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LAND RESOURCES BULLETIN

SOILS AND SUITABILITY OF LEICHHARDT DOWNS SECTION: BURDEKIN RIVER IRRIGATION AREA

PART B: A DETAILED REPORT

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Land Resources Branch

Queensland Department
of Primary Industries

Queensland Government Technical Report

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Soils and Land Suitability of Leichhardt Downs Section, Burdekin River Irrigation Area.

Part B - Detailed Report

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Subject access terms - Burdekin River Irrigation Area, Leichhardt Downs Section, physical resources, soil survey, soils, land use, land suitability, limitations, management.

A 1:25 000 soil survey and land suitability evaluation were undertaken for 9650 ha of Leichhardt Downs Section in the Burdekin River Irrigation Area. Climate, geology, hydrology, vegetation and soils of the area are discussed. Complete morphological and analytical data are presented for 25 representative soil profiles of the area.

A soils map showing the 765 individual mapping units or unique map areas is included with the report.

Land suitability classifications using a five class system were used to evaluate the suitability of each unique map area for sugar-cane, grain crops, small crops, mangoes and rice. Maps showing the land suitability classes for these crops and crop groups are included in the report.

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ABSTRACT

A 1:25 000 soil survey and land suitability evaluation were undertaken for Leichhardt Downs Section in the Burdekin River Irrigation Area (BRIA). The Leichhardt Downs Section, situated on the Home Hill side or right bank of the Burdekin River, comprises 9650 ha. The survey was conducted primarily to provide land resource information and land suitability criteria to assist the Queensland Water Resources Commission with resubdivision and farm design for subsequent irrigation farms. It is the first of a series of high intensity surveys proposed for the BRIA for this purpose.

This report, Part B, although containing some of the tables presented in the summary report Part A, provides more information on the physical resources and land use of the survey area. The resources of the area are discussed in terms of climate, geology, hydrology, vegetation and soils.

Eighty-three mapping units consisting of 70 soil types, nine variants and phases and four miscellaneous units were identified and mapped. The 765 individual mapping units or unique map areas are shown on the accompanying soils map. The six landscape units identified in the area as well as the soil types are described in detail.

Complete morphological and analytical data are presented for 25 soil profiles which were sampled and analysed during the survey. These 25 soil profiles were representative of 19 important soil types of the area. Results of analyses from these soil profiles as well as those from 13 soil profiles representing a further seven soil types sampled from previous surveys were used to describe in detail the chemical and physical attributes of the soils.

Land suitability classifications using a five class system were used to evaluate the suitability of each unique map area for sugar-cane, grain crops, small crops, mangoes and rice. Maps showing the land suitability classes for these crops and crop groups are included in this report. The limitations affecting the suitability of the land for irrigation are discussed.

The major problems affecting the management of the soils of the area are discussed. Measures to decrease the affects of land degradation such as salinisation, flooding and erosion are outlined.

1. INTRODUCTION

1.1 History

About 900 ha of sugar-cane were irrigated by underground sources in the Lower Burdekin Valley by 1896. During the expansion of this industry, a number of storages have been constructed to either augment the supply of water to the underground supplies or increase surface supplies to allow an expansion of irrigated lands. These storages include the Gorge, Blue Valley and Clare weirs on the Burdekin River and the Val Bird weir on the Haughton River, and the Eungella Dam on the Broken River.

Investigations of the feasability of establishing the Burdekin River Irrigation Area (BRIA) adjoining the present irrigated lands were undertaken by the Commonwealth and State Governments. After considering the recommendation of the Burdekin Project Committee (1977), the Burdekin Project Assessment Committee (1978) concluded that a dam should be constructed on the Burdekin River, primarily to provide adequate water supplies to irrigate sugar-cane, rice and other crops on new lands in the Lower Burdekin Valley. A decision was made to commence the Burdekin River Irrigation Project in 1980.

The Burdekin Falls Dam with a capacity of 1.86 million megalitres was completed in 1987. Considerable progress has been made with the construction of the main distributory channels and drainage works in the proposed irrigation areas.

The scheme, designed to be implemented over 20 years, is expected to provide up to 500 new farms for irrigated cropping. The first farms were released in 1988. The planning and design of the irrigation area is under the control of the Queensland Water Resources Commission (QWRC).

1.2 Purpose and extent of survey

Regional reconnaisance soil or land surveys of Skerman (1951), Christian et al. (1953), Hubble and Thompson (1953), Isbell and Murtha (1970) and Van Wijk (1971) were considered inadequate for irrigation project planning. However, surveys by Thompson (1977) and Reid and Baker (1984) at a scale of 1:100 000 provided sufficient information to assess the irrigation potential of areas in the Lower Burdekin Valley. High intensity surveys at a scale of 1:25 000 were considered appropriate for the purposes of providing detailed resource information and land suitability assessment to assist QWRC in resubdivision and farm design for irrigation.

The first area in the Burdekin River Irrigation Area (BRIA) to be subdivided into irrigation farms on the Home Hill side or right bank of the Burdekin River is Leichhardt Downs Section. A 1:25 000 survey of 9650 ha* of this section was therefore undertaken. This survey is the

* This digitised area for the section differs from that in Donnollan et al. 1986.

first of a series of 1:25 000 soil surveys being undertaken in the BRIA.

The Leichhardt Downs Section adjoins the Burdekin River and extends from 3 km upstream of Clare Weir to 18 km downstream. The other boundaries are located 200 to 500 m upslope from the Elliot main channel, the main distributory channel of the right bank, and the foothills of Stokes Range. A plan showing the location of the area in respect to other proposed 1:25 000 soil surveys of the BRIA is shown in Figure 1.2.1.

Donnollan et al. (1986) presented a summary of the soil and land use information from this survey in Part A. This report, Part B, although containing some of the tables presented in part A, provides more details of the physical environment, the soils, their physical and chemical attributes as well as land use implications.

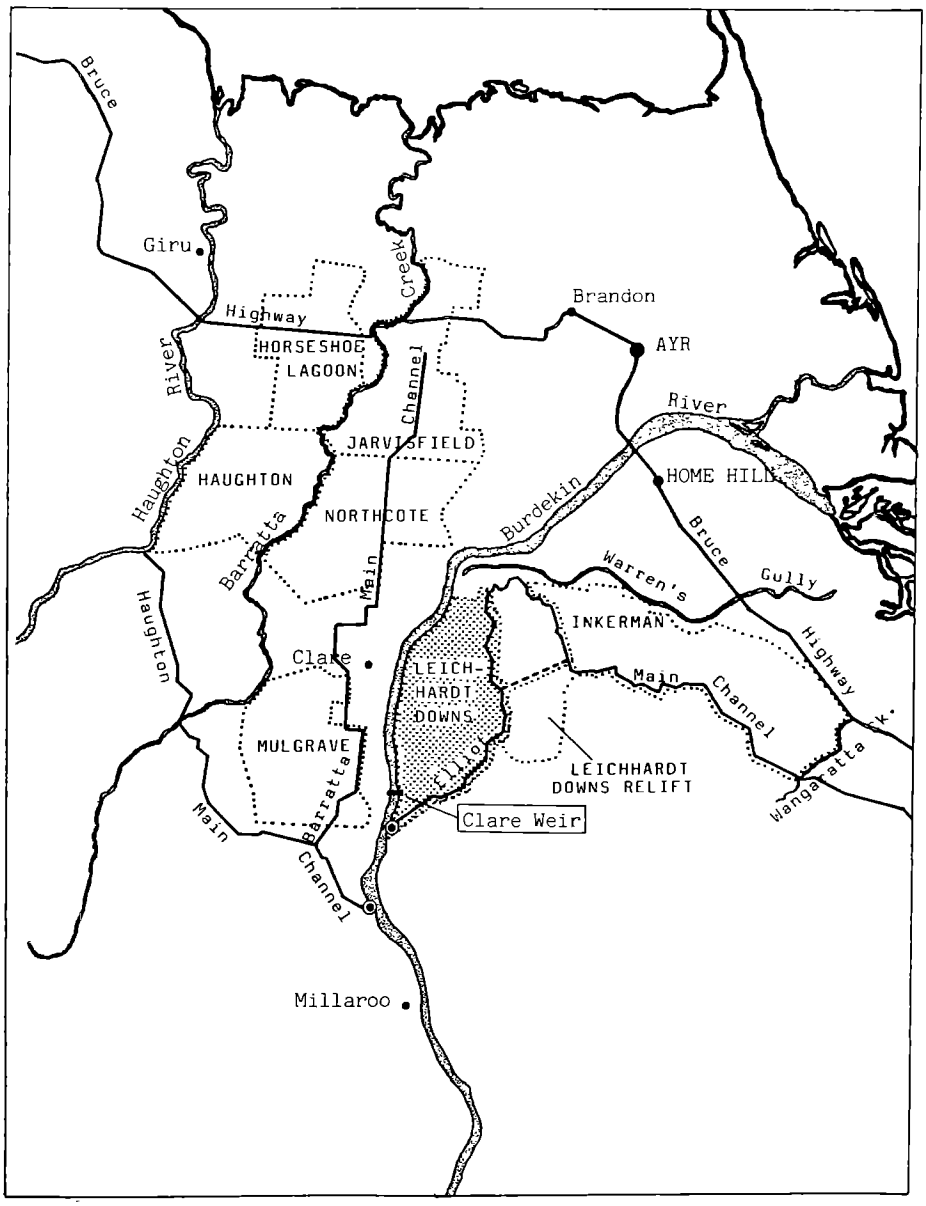


Figure 1.2.1 Locality plan

2. PHYSICAL RESOURCES

2.1 Climate

2.1.1 Introduction

The survey area is within the regions of which climate has been discussed in Christian et al. (1953), Australian Bureau of Meteorology (1970) and Burdekin Project Committee (1977). The climate of the study area can be described as warm and sub humid with well defined wet and dry seasons.

No weather recording stations lie within the survey area. Clare, situated approximately 6 km in a westerly direction from the survey area is the nearest rainfall recording station. Millaroo Research Station, about 30 km south of the area and Ayr Research Station, 22 km north north-east, are the nearest weather recording stations. Temperature and evaporation rates for the survey area are expected to lie between those values of the two recording stations.

2.1.2 Rainfall

The average annual rainfall for Clare for the 35 year period from 1952-1986 is 893 mm. Mean monthly rainfall for Clare for the same period is shown in Figure 2.1.1. Seventy-five percent of the total rainfall falls between December and March.

Rainfall variability is high. Figure 2.1.2 shows the monthly rainfall in millimetres likely to be equalled or exceeded 10 percent, 50 percent and 90 percent of occurrences. Annual totals vary from 256 mm in 1969 to 1783 mm in 1956.

2.1.3 Temperature

Mean daily maximum and minimum temperatures are shown for Millaroo and Ayr Research Stations in Figure 2.1.3 and 2.1.4 respectively. The mean daily maximum temperatures at Millaroo Research Station are slightly higher throughout the year than those of Ayr Research Station. The mean daily minimum temperatures at both stations are similar from November to March but slightly lower at Millaroo for the remainder of the year.

On the basis of frosts occuring at screen temperatures below 2°C, only two frosts have occured in July at Ayr Research Station between 1965 and 1983 (Source: Bureau of Meteorology). However, further inland at Millaroo, a total of 29 frosts between June and August have occured over the same period.

Heat waves (temperatures > 38°C) are rare at Ayr with a frequency of .33 days a year, while at Millaroo the frequency is 2.2 days per year.

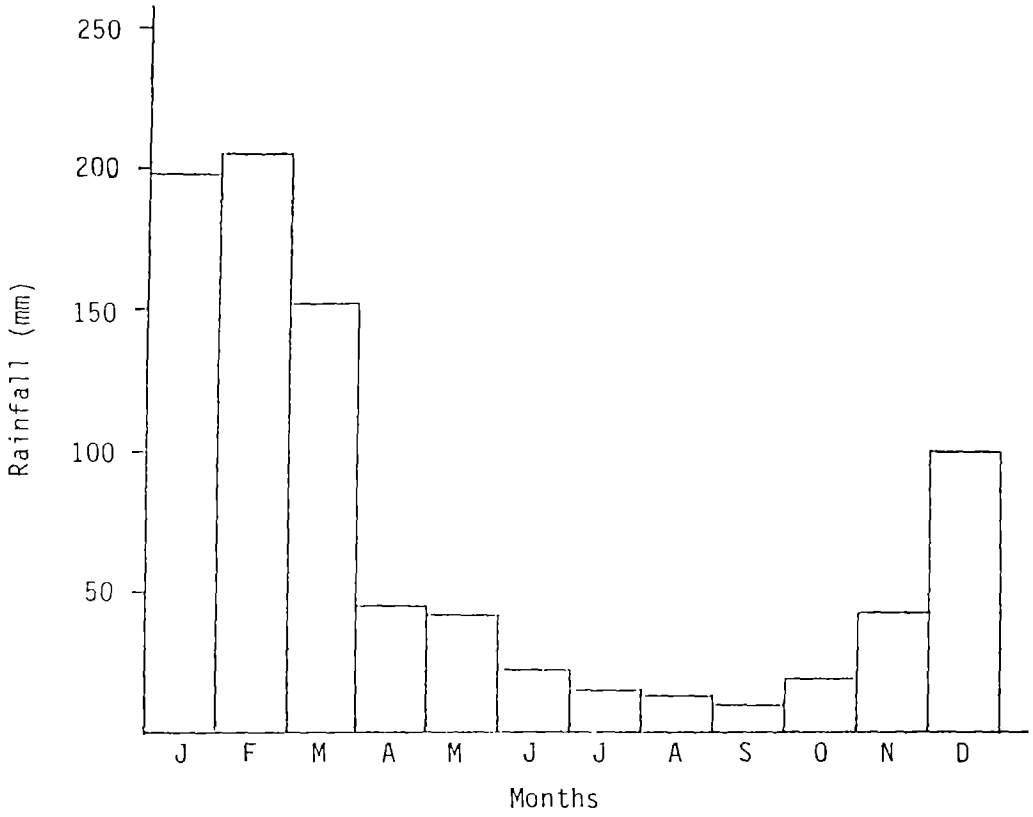


Figure 2.1.1 Mean monthly rainfall for Clare (Source: Queensland Water Resources Commission).

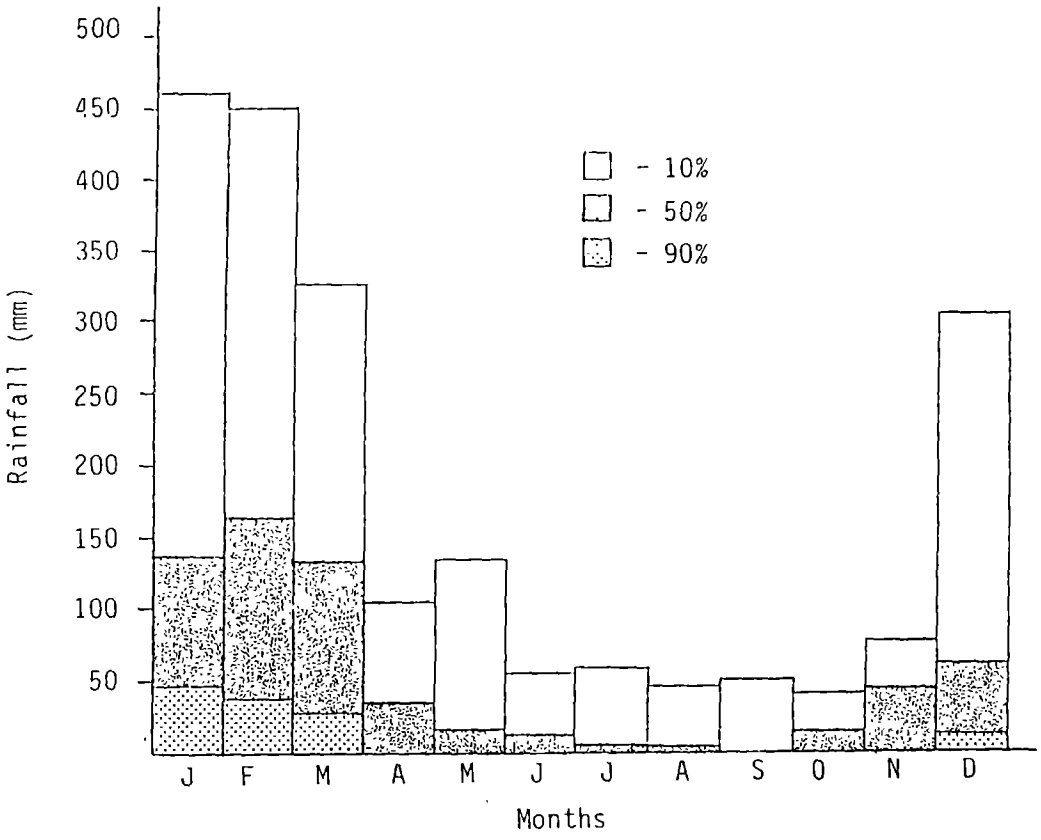


Figure 2.1.2 Monthly rainfall values likely to be equalled or exceeded in 10, 50 and 90 percent of occurrences for Clare (Source: Queensland Water Resources Commission).

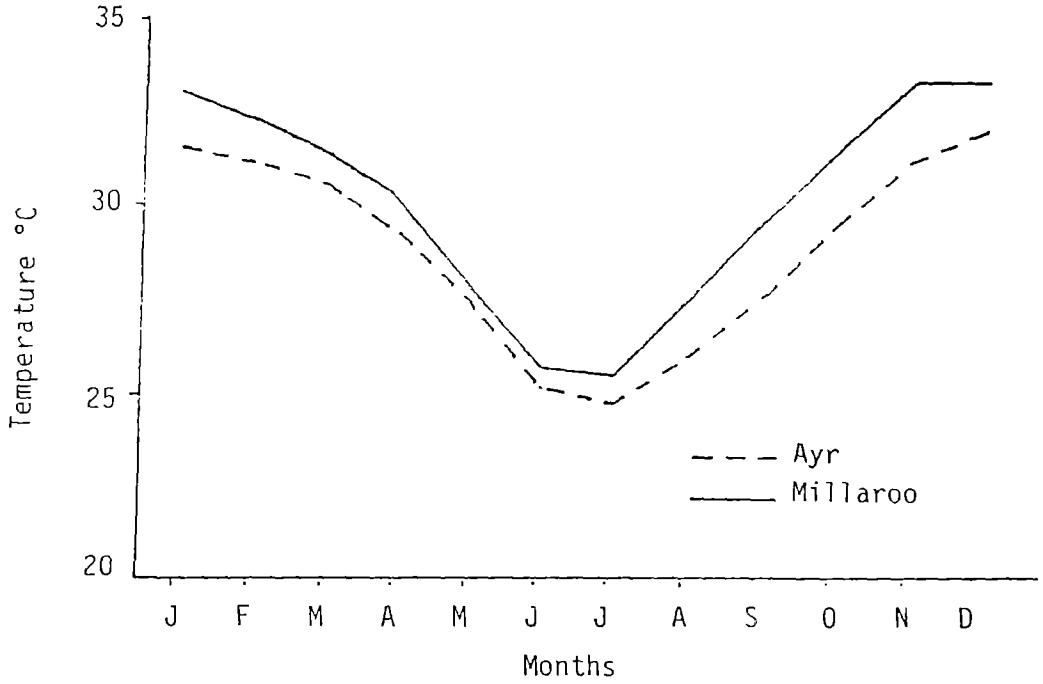


Figure 2.1.3 Mean daily maximum temperatures for Millaroo and Ayr Research Stations (Source: Australian Bureau of Meteorology)

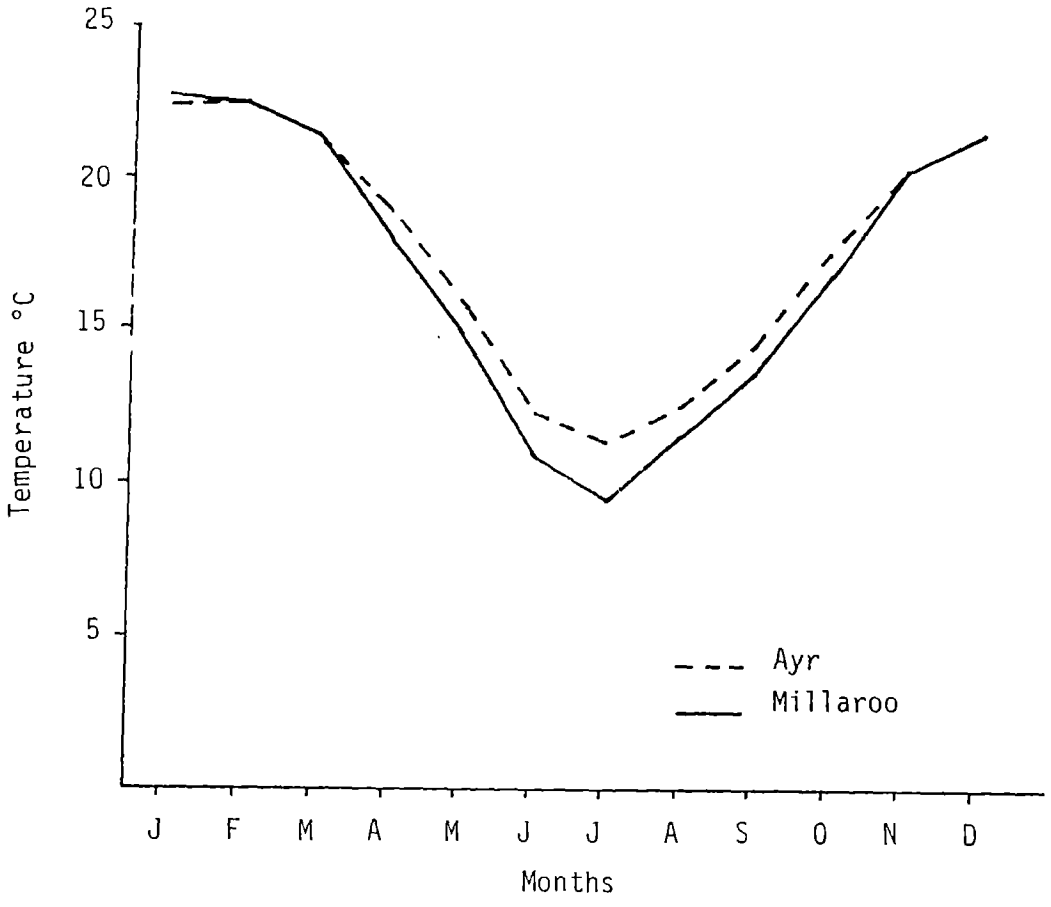


Figure 2.1.4 Mean daily minimum temperatures for Millaroo and Ayr Research Stations (Source: Australian Bureau of Meteorology)

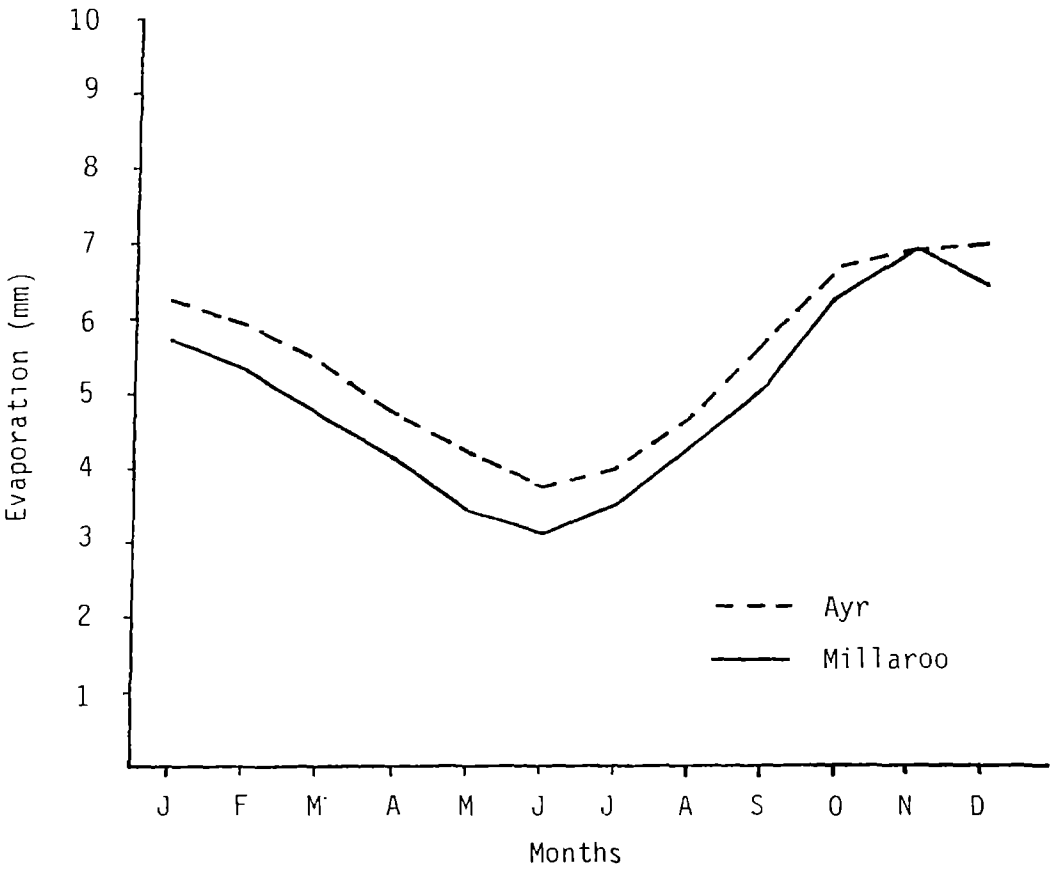


Figure 2.1.5 Mean daily evaporation for Millaroo and Ayr Research Stations (Source: Australian Bureau of Meteorology).

2.1.4 Evaporation

Mean daily pan evaporation at Ayr and Millaroo Research Stations is shown in Figure 2.1.5. Although the mean daily maximum temperatures for Millaroo are higher than those of Ayr, pan evaporation is slightly lower. This may be partly explained by the lower wind speeds at Millaroo. At Ayr, wind speeds are approximately equally divided between the 1 to 6 knot and 7 to 15 knot ranges, while at Millaroo speeds are mostly within the 1 to 6 knot range (Burdekin Project Committee 1977).

2.2 Geology and landscape units

2.2.1 Geology

Gregory (1969) mapped and described the geology of the 1:250 000 Ayr geological sheet while Paine (1972), at a scale of 1:1 000 000, described and mapped the Burdekin and Townsville Region. The geomorphology of the Burdekin Delta has been described by Hopley (1970). Ellis (1983) described the geology of the Leichhardt Downs Section. Thompson et al. (in preparation) described the chronology and morphogenesis of the Lower Burdekin Valley.

The oldest rocks of the area are the Upper Carboniferous-Lower Permean Dioritic Complex (C-Pd), (Gregory 1969), and are part of the Conners Arch (Paine 1972). Stokes Range is a part of this unit. The range of plutonic rocks within this unit include diorite, quartz diorite, tonalite, gabbro and norite with minor granodiorite, adamellite and granite. Within the unit, dykes recognisable from either outcrop or from contrasting soils formed from different parent materials, are usually located in a north north-west direction, often at about 330°.

The dykes are of varying composition (Gregory 1969, Ellis 1983). Basic to intermediate dykes (microdiorites and dolerites) are the most widespread. The acid dykes (felsites, microgranites, granophyres and porphyries) are generally much thicker than the basic to intermediate dykes. Ellis (1983) suggested two alternate methods of intrusions of these dykes. The earliest C-Pd rocks were granitic and were intruded along the regional grain by numerous basic dykes or secondly, the unit was mainly basic and the granitic rocks intruded. Another sequence of events in the northern portion of the survey area has been observed by Hughes (personal communication) from soil pits and an exposed cutting where the basic basement rock, diorite, was intruded by a more basic rock, andesite.

The Inkerman Shear Zone (Gregory 1969), extending from Mount Inkerman east of the survey area to Stokes Range, consists of coarse grained plutonic rocks that have been sheared and recrystallized to gneiss, garnet, epidote and tremolite. The 3 km wide shear zone lies perpendicular to the general regional structure.

A granitic intrusion (C-Pg unit) located in the south of the area intruded the C-Pd unit. Adamellite, granite, some granodiorite with minor fine grained variants are the major rocks in this unit (Gregory 1969).

The Mt Louisa area (C-Ph unit), just south of the survey area, is a resistant plug consisting of rhyolite, trachyte and trachyandesite (Gregory 1969). Ellis (1983) suggested that some of the acid to intermediate dyke rocks in the C-Pd unit may have been derived from this intrusion. The youngest plutonic intrusion, of the Permian to Mesozoic period (P-Mg unit), occurs in the Gap area in the south east of the survey area and consists of leucocratic adamellite, granite, granophyre, synetite and rhyolite. This unit has intruded both the C-Pd and C-Pg complexes. Ellis (1983) suggested that the acid dykes of the Stokes Range area may be derived from this unit.

The major part of the survey area (approximately 7 000 ha) is of alluvial origin and is mapped as the Czs unit on the 1:250 000 geological map.

Evans (personal communication) refutes the published geological evidence and proposes that the oldest rocks of the Stokes Range - Leichhardt Downs Section are a previously unrecognised metamophoric unit. The major country rock types are lineated amphibolite, leucogranite, migmatite, biotite and muscovite rich schists, and gneiss. The unit is the oldest geological unit in the area and has been subsequently deformed and intruded by igneous dykes of many phases. The dykes are largely intermediate in composition and include andesites, andesite porphry, microdiorite, dolerite, microgranodiorite and lesser acid dykes including rhyolite, felsite and microgranite.

2.2.2 Landscape units.

Thompson (1977) divided the right bank of the Burdekin River on relief characteristics and identified six topographic forms based on differences in geology or geomorphology. Since this report has been published, some terms and definitions relating to the components of soil and land surveys have changed. Landscape unit* (LU) (adapted from Thompson and Moore 1984) replaces the term topographic form. Some of the definitions of the landscape units have also been altered slightly to agree with the terminology of McDonald et al. (1984).

The six landscape units present in the study area are:

Landscape unit 1: Local alluvial plains and associated pediments.
Landscape unit 2: Burdekin River alluvial plain.
Landscape unit 3: Local alluvial plain.
Landscape unit 4: Gently undulating rises on acid intrusive rocks, pediments and prior streams.
Landscape unit 5: Gently undulating rises on an intrusive rock complex.
Landscape unit 6: Miscellaneous alluvial landforms.
- A: Burdekin River alluvial landforms.
- B: Creek and relict alluvial landforms.

Figure 2.2.1 shows a general relationship of the relative positions of the landscape units.

* See glossary

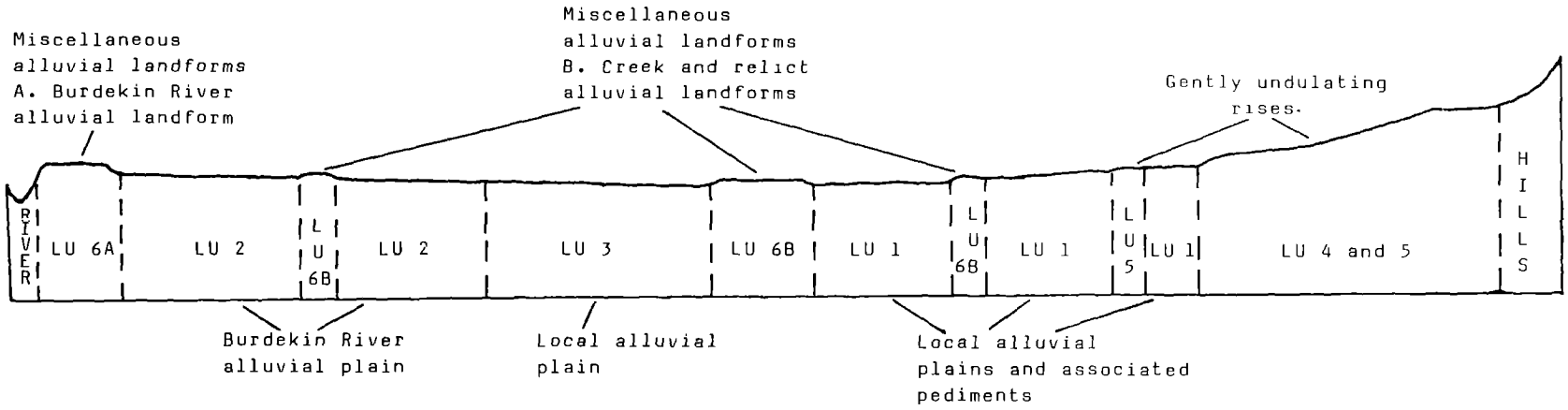


Figure 2.2.1 Diagram showing relative positions of the landscape units of Leichhardt Downs Section, Burdekin River Irrigation Area.

Landscape unit 1. The local alluvial plains and associated pediments are low lying plains and pediments of clayey sediments located below hills and gently undulating rises. These deposits are considered to have resulted from the weathering and erosion of nearby hills during the Pleistocene interglacial period. (Hopley 1970). From deep borings undertaken by QWRC, depth to bedrock varies from 1 m to 10 m.

Landscape unit 2. The alluvial plain of the Burdekin and Haughton Rivers was mapped extensively on the left bank of the Burdekin River (Reid and Baker 1984). In the study area, the Burdekin River alluvial plain is confined to the central and south-western area adjoining the present Burdekin levee.These flood plain deposits are generally fine textured and are considered to have been deposited during the Pleistocene/Holocene period. Depth to basement rock varies from 20 m in the south to four metres in the vicinity of Cassidy Creek.

Landscape unit 3. These local alluvial plains are located in an embayed position bounded by landscape units 1, 2, 5 and 6. Thompson et al. (in preparation) postulated that these plains were lacustrine or swamp areas trapped behind the Pleistocene interglacial dunes. The dune barriers were eventually breached by incision in the Pleistocene period when the climate became more arid and sea level fell.

Landscape unit 4. Small areas of this landscape unit occur in the south west of the area. Upper Carboniferous to Lower Permian volcanics and intrusives (C-Ph unit) are the dominant rocks of this unit. The main components of this landscape unit are the pediments and prior streams associated with the lower slopes of Mt. Louisa.

Landscape unit 5. This landscape unit lies on the major geological structural unit (C-Pd unit) described previously. The slopes of the gently undulating rises of landscape unit 5 range from 0.5 to 3 percent. Dyke rocks are exposed in many places. Contrasting soils also indicate the presence of dykes.

Landscape unit 6. This landscape unit has been subdivided into the Burdekin River alluvial landform and the creek and relict alluvial landform based on the the source of the depositional material.

The Burdekin River alluvial landform is a 0.3 to 1.5 km wide levee of the present Burdekin River. The diversion of the Burdekin River to its present course through "The Rocks" has been postulated to have occurred during the Pleistocene/Holocene period (Hopley 1970). The soils of the present levee are generally medium textured with a high proportion of fine sand indicating the relatively fine depositional material of the levee.

The large relict levee that extends from the present Burdekin levee in a north-easterly direction and the small relict levees scattered throughout the Burdekin River alluvial plain suggest that the Burdekin River may have occupied a more easterly position than presently. The authors suggest that a previous Burdekin River course may have been associated with one or both of the systems identified by Hopley (1970) on

the left bank of the Burdekin River, namely to the north of Clare and to the north-west of Clare through the Burdekin Agricultural College.

The other relict and present levees, prior streams, flood-outs, fans and closed depressions which are part of the creek and relict alluvial landforms are associated with Cassidy and Stokes Creeks as well as minor creeks originating in the hills and terminating in the alluvial plains of LU 1 and LU 3. A complex distribution of soils has resulted from the deposition of a wide range of sediments, especially in the vicinity of the locally named Sheep Camp Creek in the south-east of the area.

2.3 HYDROLOGY

2.3.1 Surface hydrology

Local Runoff. The survey area is surrounded by ranges or hills in the north, south and east. The area is drained by Cassidy, One Mile and Stokes Creeks which flow into the Burdekin River. Incised creeks or gullies convey runoff from the hills and lower slopes especially in the east and south. These terminate, often as fans, at the edge of the alluvial plains of landscape units 1, 2 and 3. The runoff must then flow across very low gradient flats, often with gilgai microrelief, to Cassidy and One Mile Creeks and their tributaries. Large areas of these alluvial plains may therefore become inundated.

A flood model has been developed to estimate the extent of flooding in the Burdekin River Irrigation Area (1987). An inundation map for the Southern Leichhardt Downs Section was prepared using the results from the flood model and is shown in Figure 2.3.1. The hachured area indicates the extent of inundation from a simulated 1:10 rainfall event in the prefarm-developmental stage but with the Elliot Main Channel and associated cross flow drainage present. About 1900 ha of land, including 600 ha of landscape unit 3, would become inundated. The period of inundation is expected to be short.

The flood model was also used to determine the extent of inundation after irrigation development using a preliminary design for the proposed drains. The area of inundation was reduced by less than 10 percent and was displaced further down the catchment. A large area between Cassidy and Two Mile Creeks will become inundated with much less land on landscape unit 3 being flooded.

Little information on flooding for Northern Leichhardt Downs Section is available but the low lying cracking clays of landscape unit 1 between the gently undulating rises is expected to become inundated. Much of landscape unit 6 along Stokes Creek and the lower lying areas of landscape unit 1 adjoining, are also expected to be flooded for short periods.

Flooding from the Burdekin River. Three floods of the order of 38 000 m^3 sec^{-1}, seven of 27 000 m^3 sec^{-1} and four of 20 000 m^3 sec^{-1}

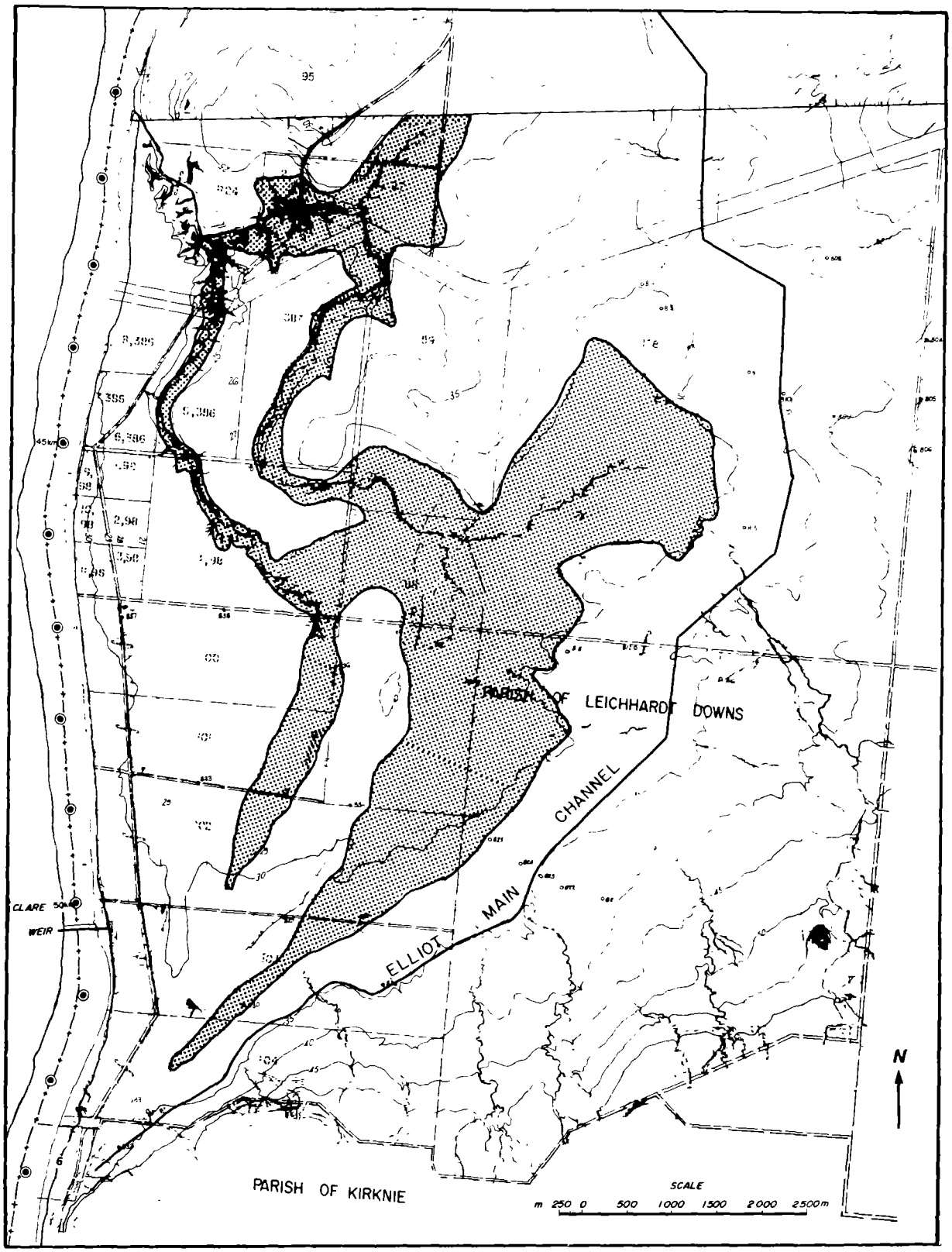


Figure 2.3.1 Inundation map of a simulated 1:10 local runoff event for the prefarm-development stage of the Southern Leichhardt Downs Section , Burdekin River Irrigation Area (Source : Queensland Water Resources Commission) .

have occured since stream height recording commenced in 1918 in the Lower Burdekin Valley (Kapitzke, QWRC unpublished report). The return periods for these events are 1:25, 1:11 and 1:7 years respectively (Burdekin Project Committee 1977).

The two smaller category flows caused ponding of local runoff water to various degrees in the Cassidy Creek basin. The 1:25 000 events (38 000 m^3 sec^{-1}) have also caused overbank flow of the Burdekin River, the main outbreak point being at Slip Rail Gully, upstream from Clare weir.

During the largest flows approximately 600 ha of the survey area was inundated to a depth greater than 2 m. The total area with some inundation was 2400 ha. The time of overbank flow varied from 18 to 36 h depending on the flood.

During floods the outflow from the local creeks is restricted by the height of the flow in the Burdekin River. During floods of the order of 27 000 m^3 sec^{-1}, water may be backed up to seven kilometres along Cassidy and One Mile Creeks. Inundation along these creeks in the 1974 flood, a high volume one, lasted for 18 days. The 20 000 m^3 sec^{-1} floods back up water in Cassidy Creek but inundation is minimal.

Little information is available on the affects of high flows in the river on the northern section of the survey area. However, it could be assumed that the outflow from Stokes Creek would also be impeded by the height of the flow in the Burdekin River causing back up flooding along this creek. The amount of inundation is unknown.

Kapitzke (QWRC unpublished report) suggested a levee constructed across the saddle at Slip Rail Gully (upstream of Clare weir) should minimise overflows from the River during large floods and therefore reduce the extent and depth of inundation. A rocky restriction, 1.5 km in length in Cassidy Creek, downstream of Leichhardt Lagoon, impedes the flow in this creek and extends the duration of ponding upstream (Kapitzke, QWRC unpublished report). Kapitzke recommended that improvements to the creek at this restriction should be made to reduce the period of inundation.

With the development of the survey area for irrigation, adequate measures to reduce the period and depth of inundation will have to be made. Provision must be made for adequate cross drainage under the Elliot main channel to convey local runoff from catchments upslope of the channel. A network of well grassed drains will be required to convey runoff water from the cross-drains across the alluvial plains to the main drainage systems of the scheme, namely Cassidy, One Mile and Stokes Creeks.

2.3.2 Subsurface hydrology

Thompson (personal communication) recognised nine salt outbreaks on the right bank of the BRIA which resulted primarily from land clearing. Generally, these outbreaks occurred on the lower slopes of the gently undulating rises and at the interface between the gently undulating

rises and the heavy clays of the local alluvial plains. Thompson (1980) described the factors occurring in a saline seep development for one of these toposequences. These studies by Thompson (1980) and further refinement by Shaw (1982) enabled a simple hydrological model of toposequence salinisation to be developed. The landscape was divided into recharge areas, transmission zones and discharge areas.

The recharge areas usually occur on upper slopes of convex topography on landscape unit 5. The soils on the recharge areas overlie fractured and weathered rock material at 0.7-1.2 m. These soils (5Dra,* 5Dya) have low salinity and are neutral to slightly acid with moderate to high hydraulic conductivities (3.1 mm hr^{-1} for 5Dra, Gardner and Coughlan 1982).

The transmission zones below the recharge areas have soils (5Dyb) which are neutral to alkaline in the subsoils and have lower hydraulic conductivities. These soils are usually deeper and the underlying rock material is usually more weathered.

Discharge areas occur on break of slope, flat or incised areas or regions of concave slope. Soils are generally deeper and have low hydraulic conductivities. These soils (for example 5Dyc) are alkaline to strongly alkaline and have moderate to high levels of salt in the profile.

Water infiltrates through the soils of the recharge area and enters the fractured and weathered rock material which has lower hydraulic conductivities. The water flows downslope until reaching an area of restricted permeability such as the heavy clays of the local alluvial plain. Water levels rise in the discharge areas and as soils of these areas have high levels of salts, salinisation occurs. Non-saline seeps may develop in the transmission zones.

Other toposequence salinisation outbreaks have occurred with clearing in areas other than between the gently undulating rises and the local alluvial plain. To the east of Stokes Range, salinisation has occurred at the interface of landscape units 3 and 1, 3 and 2, 3 and 6 and 1 and 6. Often prior streams in landscape unit 6 act as recharge areas or distributory channels. Salinisation has occurred where permeability discontinuities are present.

Dykes can also act as barriers to groundwater and cause salinisation upslope of the dyke. On the gently undulating rises, the position of dykes can usually be determined either by soil type changes, changes in vegetation density or the presence of rock fragments on the surface. However, subsurface dykes are difficult to locate under soils of alluvial origin and potential salinisation of these situations will be difficult to predict.

A number of organisations has expressed concern that more widespread salinisation may occur in these toposequences as well as in other situations under irrigation. In the survey area a hydrosalinity

* See Section 3.

reseach project, to investigate the hyrological aspects of a toposequence situation under irrigation is being undertaken by QDPI in collaboration with QWRC, CSIRO and James Cook University. This project, on the Leichhardt research block (AMG of centroid, 532750E, 78090500N) involves the furrow irrigating of 50 ha of maize and soybeans on permeable soils, mainly 5Dra. The main objectives of the study are to determine (i) the magnitude of water table problems which develop when these landscapes are furrow irrigated, (ii) the amount, timing, distribution and causes of deep drainage when these landscapes are furrow irrigated and (iii) whether a systems model can be developed to establish a hydrosalinity ground water model (Gardner personal communication).

Waterlogging and salinisation of about 45 ha has occurred below a leaking farm dam just east of the survey area. The effectivness of drainage to reduce this problem was investigated by Shaw et al.(1982). Even though two open drains (each 2 m deep) accounted for 75% of the calculated dam leakage, the drains were ineffective in rehabilitating the affected area. The main reasons for their failure were that their depth, spacing and drain outfall were inadequate in lowering the water levels. This study indicated that effective drainage may be difficult, especially on soils of low hydraulic conductivity which are present in the potential discharge areas. The depth and spacing of subsurface drains, their hydrological effectivness and their cost, is being investigated further as part of the hydrosalinity research project.

QWRC have installed 132 bores either within the Leichhardt Downs Section or close to the boundaries. Location of these bores is shown in Figure 2.3.2. Little information on ground water levels and electrical conductivity is available from most of the bores which were installed between 1981-83, as rainfall has been below average during this period. However levels and electrical conductivity of the ground water have been measured in some bores since 1975-76. Figures 2.3.3 to 2.3.7 show these trends for selected bores of the area. The bimonthly bar graph of rainfall for Clare is also presented in the figures.

All bores except 242, which is on the lower pediments of landscape unit 1, show responses in ground water levels to rainfall. The level of bore 242 has remained relatively stable between 10 and 11 m. The level of the ground water of bores 244 and 245 on the lower slopes of the gently undulating rises (LU 5) flucuates between 4 and 10 m of the land surface. Bores 240 and 241 on the Burdekin levee are particularly responsive to rainfall but the water levels are much deeper at depths ranging from 11 to 17 m of the surface.

The quality of ground water of bores 240, 241 and 245 ranges from 2 to 4 dS m^{-1}. In bore 244, the quality ranges from 0.5 to 4 dS m^{-1}. The electrical conductivity of the water for most of the period of analyses in bore 242 ranges from 5 to 9 dS m^{-1} which is regarded as generally unsuitable for irrigation (Gill 1984). Salt concentration usually decreases as the water level increases, although this response does not always occur.

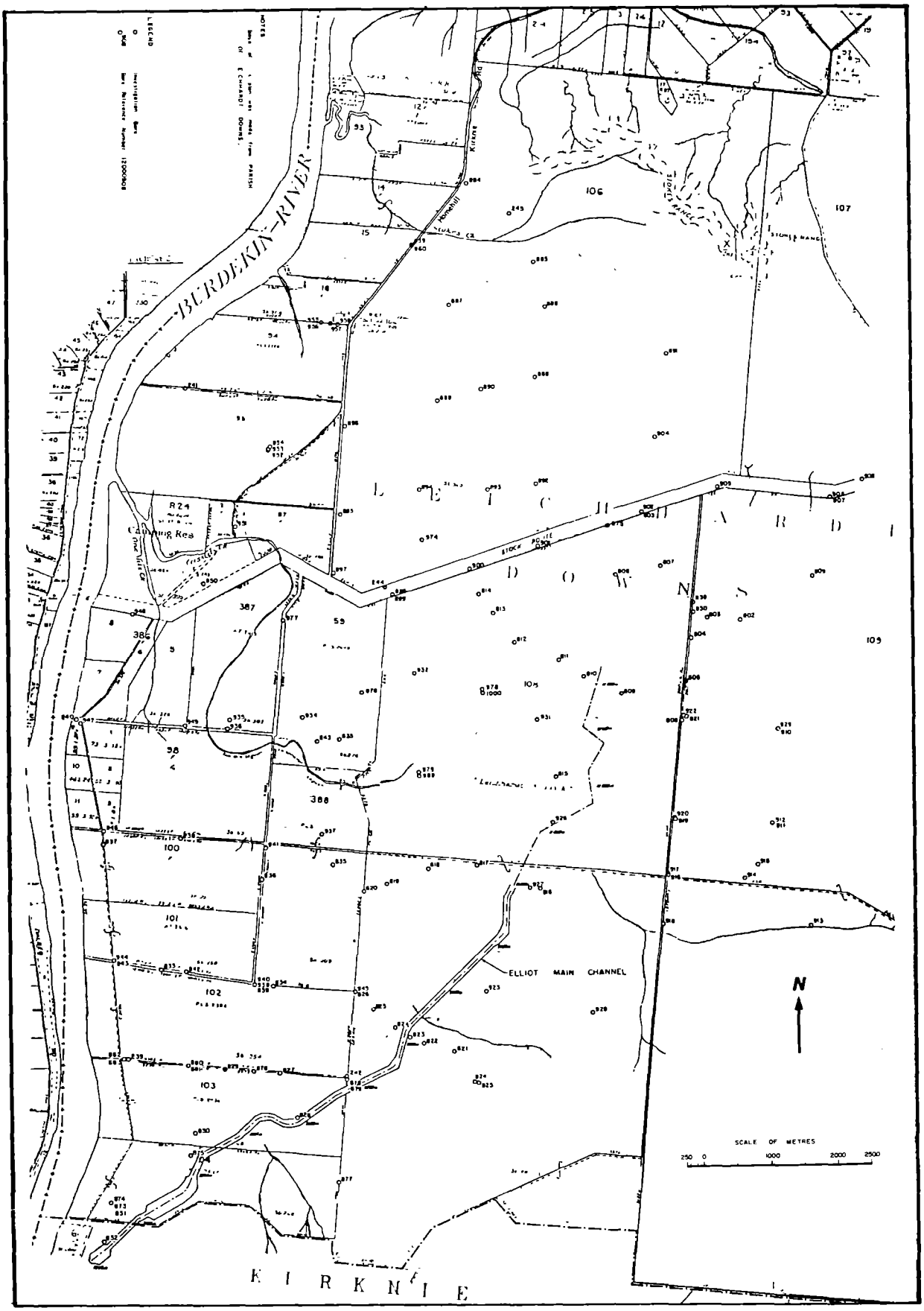


Figure 2.3.2 Location of bores in Leichhardt Downs Section, Burdekin River Irrigation Area , (Source : Queensland Water Resources Commission).

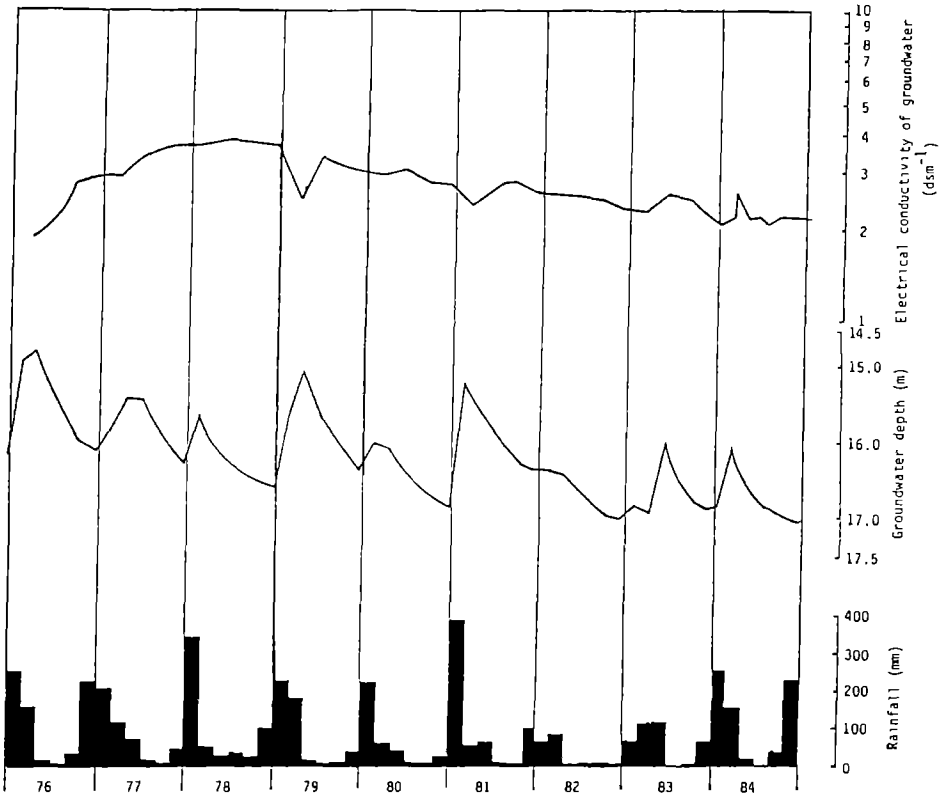


Figure 2.3.3 Changes in groundwater depth and quality of bore 240 (LU6) with rainfall
(Source: Queensland Water Resources Commission)

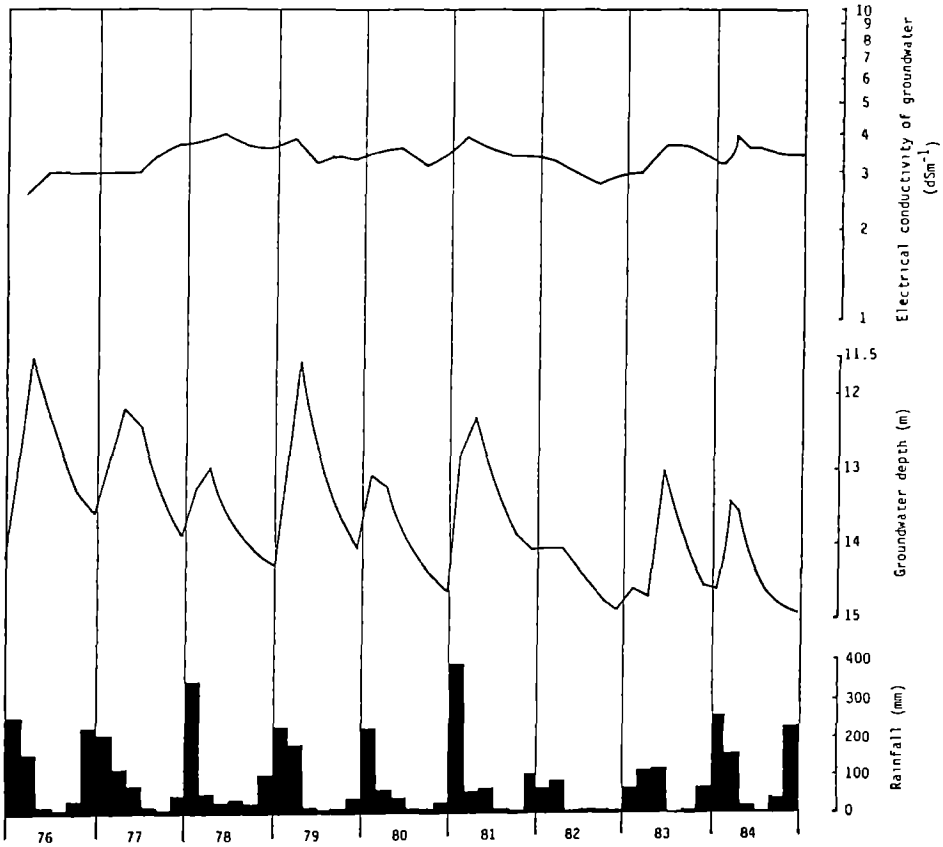


Figure 2.3.4 Changes in groundwater depth and quality of bore 241 (LU6) with rainfall
(Source: Queensland Water Resources Commission).

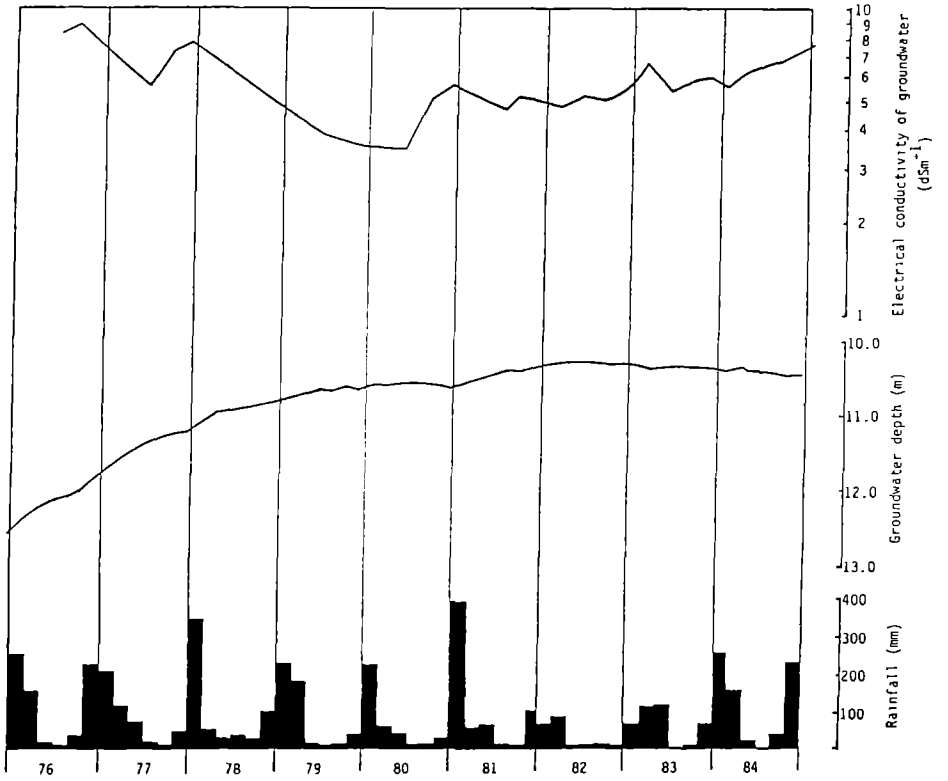


Figure 2.3.5 Changes in groundwater depth and quality of bore 242 (LU1) with rainfall (Source: Queensland Water Resources Commission).

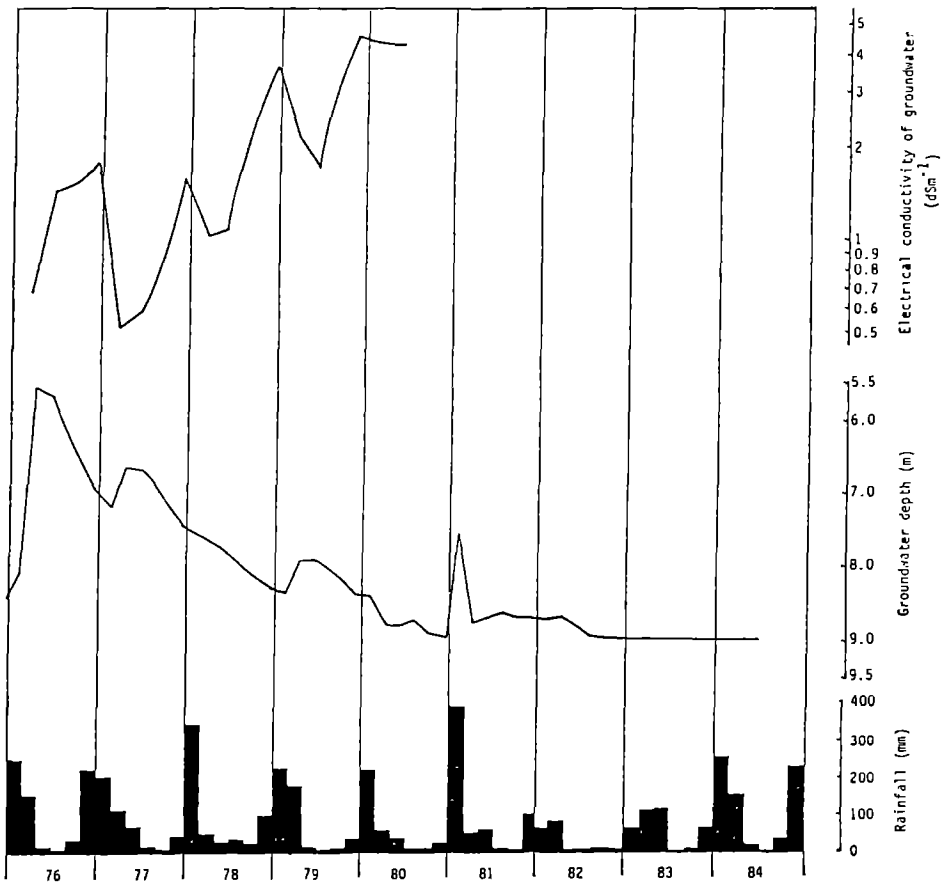


Figure 2.3.6 Changes in groundwater depth and quality of bore 244 (LU5) with rainfall (Source: Queensland Water Resources Commission).

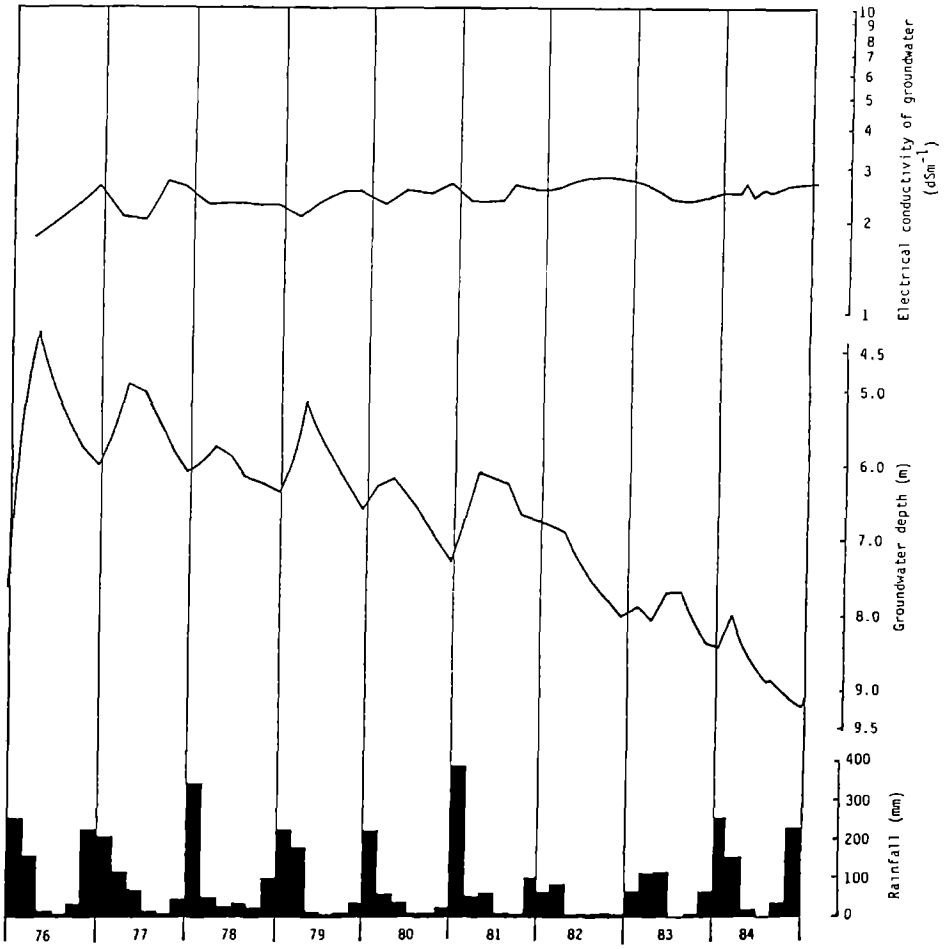


Figure 2.3.7 Changes in groundwater depth and quality of bore 245 (LU5) with rainfall (Source: Queensland Water Resources Commission).

Of other bores in the area of which electrical conductivity of ground water is available, the quality of water of bores 803 and 827 is too saline for irrigation, (> 8 dS m^{-1}, Gill 1984), for the four year period of analyses. Other bores, including 802, 818, 819, 835, and 837 have water quality which is unsuitable for irrigation for some of the sampling period. Bores 802 and 803 are located below the leaking farm dam (see section 2.3.2). Bore 827 is located on the lower pediments of LU 1 (UMA 75). Bores 818, 819 and 835 are located on LU 3 and 837 on the Burdekin River levee (LU 6).

Current research on subsurface hydrology will identify more clearly the hydrological processes operating. This research information will enable decisions on development and management to be made to decrease the incidence of salinisation. Identification of areas with potential salinisation problems is required. The height of watertables in the area must be continuously monitored especially after development to observe changes to the groundwater system.

2.4 Vegetation

2.4.1 General

The study area lies within the region of which vegetation has been described by Isbell and Murtha (1972). Thompson (1977) also described the general soil-vegetation associations of the area. The most common structural form and species composition of the soil type are described in Table 4.1.1. The main species found within the area are listed in Appendix I.

Much of the natural vegetation has been disturbed by man. Trees on portion 108 have been poisoned, pushed, windrowed and burnt. Portion 59 and part of 388 has been cleared and is cropped. Much of the present Burdekin levee is also cropped.

2.4.2 Structural form

The most common structural form (Specht 1970) is low open woodland. However woodland, low woodland and open woodland are also present.

Low woodland may occur on the cracking clays with light to light medium clay surfaces (2Ugc, 2Ugd, 2Uge)* and the duplex soils with A horizon > 0.2 m (2Dbc and 2Dbd) of LU 2 and the soils on the upper to midslopes of LU 5 (5Dra, 5Dya and 5Dyb). Woodland may occur on some of the soils on the levees, floodouts and fans, and prior streams of LU 6. Low to tall scrubland may occur on the strongly sodic solodic-solidized solonetz (5Dyc, 6Dbh, 1Dya, 2Dba).

The soils of LU 3, except for 3Ugk and 3Ugf, are treeless and support a tussock grassland. Some mapping units of 2Ugh and 2Ugg are also treeless. Tussock grassland is also the most common lower structural formation in other landscape units. Open tussock grassland

* See Section 3.

is common on the more sodic solodic-solodized solonetz of all landscape units.

Generally, the density of trees on the cracking clays, especially in the lower lying areas of LUs 1 and 2, is lower than that on the duplex soils. An exception is the low tree density on soil mapping units 2Dyb and 2Dbb on all areas except in the northern and western area of LU 2. Tree density on the cracking clays with light to light medium clay surfaces (2Ugc, 2Ugd and 2Uge) of LU 2 is usually higher than that of the cracking clays with medium to heavy clay surfaces (2Ugg and 2Ugh). The vegetation on the cracking clays (5Uga, 5Ugb and 5Ugc) of LU 5 ranges from grassland to isolated trees to low open woodland.

2.4.3 Composition

The composition of the structural forms varies with the landscape units and the soil types. Poplar gum is the dominant tree species of most mapping units of all landscape units. Open woodland, dominated by carbeen, is however present on some mapping units in LUs 1 and 2. Other species present on landscape unit 1 and 2 include cabbage gum, beefwood, tea-tree and false sandalwood. Beefwood is usually present on solodic-solodized solonetz, tea-tree on mapping units where waterlogging occurs and false sandalwood on thin surfaced, strongly sodic solodic-solodized solonetz such as 2Dba.

The dominant vegetation on the upper and midslopes of LU 5 is grey ironbark and red bloodwood with poplar gum and grey bloodwood associated. Grey ironbark on mapping units 5Dyc is rare, with cabbage gum, carbeen and beefwood becoming more important. Often false sandalwood is present on mapping unit 5Dyd.

The vegetation of LUs 4 and 6 is more diverse than that of other landscape units especially on mapping units of deep sands, soloths, podzolic soils and non-cracking clays. Species present include poplar gum, carbeen, cabbage gum, bloodwoods, tea-trees, leichhardt tree, Burdekin plum, cocky apple and coral tree. Pandanus is indicative of deep sands of prior streams.

Cane grass and blue grasses are the most common grass species of LU 3. These grasses are also common on the lowest strata of cracking clays in LUs 1, 2 and 5. Black spear grass and blue grasses are common on the solodic-solodized solonetz of all landscape units. Giant spear grass and kangaroo grass are species common to the soils of the upper and midslopes of LU 5 (5Dra, 5Dya, 5Dyb) but rare on the lower slopes (5Dyc, 5Dyd).

Sedges are common in wetter areas especially in the depressions of cracking clays.

A number of introduced shrub species are growing on parts of the area, mainly along creeks and drainage lines. Rubber vine is common along Cassidy, One Mile, Stokes and Sheep Camp Creeks and other smaller drainage lines. Jerusaleum thorn is common at the head of Cassidy Creek on soil type 3Uga, and on soil type 2Ugg and 2Ugh of Portion 101 and 102.

3. SOIL SURVEY METHOD

3.1 Background

Three low intensity soil surveys (1:100 000) have been completed in the Lower Burdekin Valley by officers of QDPI. Areas covered by these surveys were:

- Right bank (Burdekin River east to Elliot River) (Thompson 1977);
- Left bank (Burdekin River west to Haughton River) (Reid and Baker 1984);
- Southern area (Redbank Creek in the west to Bobs Creek in the east and south to the junction of Bowen and Burdekin Rivers) (Thompson et al. in preparation).

From these surveys, soil profile classes were determined from soil profile descriptions recorded predominantly from 1:25 000 reference areas of the right and left bank surveys and from the whole area of the southern area. These soil profile classes (Thompson and Reid 1982) were used as the basis for classifying soils in this survey. However, after reports on these surveys were published, the term soil profile class has been replaced by soil type. McDonald (personal communication) has defined a soil type as a three-dimensional soil body such that any profile within the body has a similar number and arrangement of major horizons whose attributes, primarily morphological, are within a defined range. All profiles within the soil type have similar parent materials.

3.2 Survey procedures

Colour photographs at an approximate scale of 1:10 000 were used in the field to assist in locating soil boundaries. Pegged lines, positioned by officers of QWRC, usually perpendicular to the contour and approximately 250 m apart with pegs at 100 m intervals were used to assist in field location. Mapping sites were generally located at 200 m intervals along these lines although the intensity of sites varied with the complexity of the area. A description of the soil profile and pertinant information of the surrounding area were recorded at each mapping site.

A total of 2125 mapping sites were described and this information was stored on computer file. Many less detailed observations were noted and were also used to define soil boundaries.

3.3 Soil types

The nomenclature of soil types was similar to that used by Thompson (1977) for soil profile classes. Each soil type was identified by an alpha-numeric code: a number for the landscape unit, the appropriate subdivision of the dominant primary profile form (Northcote 1979) and a letter for each separate soil type within the landscape unit and primary profile form subdivision. For example, for soil type 5Dra, "5" denotes landscape unit 5, "Dr" indicates a subdivision of the primary profile

form (in this case, a duplex soil with red clayey subsoils) and "a" separates this soil type from other red duplex soil types within LU 5.

Descriptions of soil profiles at the mapping sites usually fitted the soil type descriptions of Thompson and Reid (1982). However, the range of morphological attributes of some established soil types was expanded to accomodate those soil profiles whose attributes were outside the defined range. Variants were used to distinguish those profiles which were similar to an existing soil type in most respects but differed in one or more of those soil properties which had important land use significance. Variants were distinguished by a number after the soil type symbols. The variants are listed and described on the soil map.

Nine new soil types were established to accomodate a substantial number of soil profiles whose attributes were sufficiently different to exclude from existing soil types, and whose areas were mappable at the 1:25 000 scale.

3.4 Mapping units

During mapping, soil profiles described at the mapping sites were assigned to a soil type and after undertaking boundary checking, the soil boundaries were marked on aerial photographs in the field. These mapping units* are of two types. A simple mapping unit in which the dominant soil type occupied more than 70 percent of an area and a compound mapping unit in which one soil type occupied less than 70 percent of an area. The simple mapping unit was identified by the code of the dominant soil type and the compound unit by the codes for the two most common soil types with the one occupying the largest area named first.

Phases were used to separate those areas in which land use or management would be affected due to the presence of certain land properties not normally present in areas with the normal soil type. Phases were distinguished by the appropriate capital letter after the soil type symbol. Areas with large quantities of surface stone or rock exposures, (R), areas affected by erosion, (E) and areas with smooth-sided open depressions < 3 m deep, (C), were mapped as phases of the dominant soil type of the area concerned.

Each occurrence of a mapping unit was named a unique map area (UMA) (after Basinski 1978). Each UMA was given a number. Information for each UMA, including the dominant and/or co-dominant soil type, minor soil types, land suitability classes for sugar-cane, grain crops, small crops, mangoes and rice and the subclasses of the limiting factors used to determine land suitability were recorded on UMA data sheets and subsequently filed on computer. Minor soil types, land suitability classes and subclasses of the limiting factors may vary among UMAs of the same mapping unit.

The UMAs were drafted from the aerial photographs to a 1:10 000 contour plan by officers of QWRC and used as a base for resubdivision

* See glossary

and farm design. A 1:25 000 soils map was compiled by Mrs. S. Wallace, Land Resources Branch, and accompanies this report. The area of each UMA was digitised and added to the UMA data file. Mapping units, areas of mapping units and the number of UMAs in each mapping unit are presented in Table 3.4.1.

Table 3.4.1 Mapping units, areas of mapping units (ha) and the frequency of UMAs in each mapping unit, Leichhardt Downs Section, Burdekin River Irrigation Area.

Mapping Unit	Area (ha)	Frequency	Total Area (ha)
1Uga	341.3	21	
1UgaE	14.1	2	
1Ugc	66.5	15	
1Ugc-1Dyc	17.7	2	
1UgcE	6.7	3	
1Ugd	378.9	21	1106.2
1Ugd-1Dyc	9.6	1	
1Ugf	248.2	9	
1UgfE	7.0	1	
1Uge	16.2	3	
1Dba	5.9	3	5.9
1Dya	34.0	3	
1Dyb	9.8	1	
1Dyc	459.5	43	
1Dyc-1Uga	4.8	1	534.3
1Dyc-1Ugc	9.9	2	
1Dyc-1Ugd	9.8	1	
1DycE	6.5	2	
1Dda	186.1	10	194.5
1Dda-1Ugc	8.4	1	
LU 1	1840.9	145	1840.9
2Uga	82.4	7	
2UgaE	17.2	1	
2Ugb	26.1	3	
2UgbE	8.5	2	
2Ugc	79.4	8	
2Ugc-2Dya	64.7	4	
2Ugd	34.2	4	
2Ugd-2Dba	6.7	2	
2Uge	154.2	11	
2Uge-2Dyc	6.9	1	960.7
2Uge-2Dyb	30.5	1	
2UgeE	2.5	1	
2Ugg	310.0	13	
2UggE-2DycE	4.6	1	
2Ugh	128.7	6	
2Ugh-2Ddb	2.3	2	
2UghE	1.8	1	
2Dba	20.2	8	
2Dba-2Dya	21.5	1	
2Dba-2Ugd	1.2	1	
2Dbb	119.6	7	
2DbbE	12.6	5	
2Dbc	43.8	3	261.1
2Dbd	29.5	3	
2DbdE	2.3	1	
2Dbe	9.8	2	
2DbeE	0.6	1	
2Dya	191.9	13	
2DyaE	6.2	1	
2Dyb	488.4	18	
2Dyb-2Uga	2.6	1	
2Dyb-2Uge	53.2	2	898.9
2DybE	92.2	5	
2Dyc	60.4	5	
2Dyc-2Ugg	4.0	1	
2Ddb	5.9	3	
2DdbE	2.3	1	8.2
2SP	13.4	1	13.4
LU 2	2142.3	151	2142.3
3Uga	533.8	4	
3Uga8	110.8	3	
3Ugd	99.7	3	
3UgdE	45.6	1	952.1
3Uge	104.1	2	
3Ugf	29.2	1	
3Ugk	28.9	1	
LU 3	952.1	15	952.1
4Ucc1-4Dyg	8.1	1	49.2
4UccR	41.1	1	
4Dba	4.2	1	4.2

Table 3.4.1 (Continued)

Mapping Unit	Area (ha)	Frequency	Total Area (ha)
4Dyg	18.8	1	
4Dyg4	12.9	2	
4DygE	5.8	1	122.8
4DygR	1.2	1	
4Dyh	70.5	3	
4Dyh3	13.6	3	
4R	2.8	1	2.8
LU 4	179.0	15	179.0
5Uga	262.4	39	
5Uga-5Dra	43.2	8	
5Uga-5Dyc	6.0	2	
5UgaE	5.8	1	
5UgaR	0.4	1	385.9
5Ugb	58.7	13	
5Ugb-5Dra	5.0	1	
5Ugb-5Dyc	4.4	1	
5Dra	1024.1	52	
5Dra-5Uga	16.3	5	
5Dra-5Ugb	43.2	4	
5Dra1	2.3	1	
5Dra1-5R	9.2	3	1121.2
5Dra3-5Uga	6.8	1	
5Dra3-5Ugb1	4.9	1	
5DraR	6.9	2	
5DraR-5UgaR	7.5	1	

Mapping Unit	Area (ha)	Frequency	Total Area (ha)
5Dya	204.0	16	
5Dya-5Uga	4.1	1	
5Dya5	3.4	1	
5DyaR	3.0	1	
5Dyb	126.1	22	
5Dyb-5Uga	1.8	1	
5Dyb-5Dyc	15.0	1	
5Dyb3	7.2	1	
5Dyc	421.1	62	
5Dyc-5Uga	13.7	5	
5Dyc-5Ugb	2.6	1	955.6
5Dyc-1Uga	4.0	1	
5Dyc-1Ugd	4.7	1	
5Dyc-5Dra	6.7	2	
5Dyc1	5.9	1	
5Dyc1-5R	6.0	1	
5Dyc3	6.2	1	
5Dyc5	2.9	1	
5DycE	4.6	4	
5Dyd	44.0	11	
5Dyd-5Uga	6.8	1	
5Dyf-5Ugc	65.8	6	
5R	11.2	5	21.8
5R-5E	10.6	1	
LU 5	2484.5	284	2484.5
6Uca	49.7	8	
6Ucc	31.4	4	85.6
6UccE	4.5	1	
6Uma	364.0	5	
6Uma2	53.9	2	
6UmaC	75.1	1	
6UmaE	62.1	4	606.3
6Umb	51.2	2	
6Ufa	8.7	1	
6Ufa-6Uga	64.2	2	113.9
6Ufd	6.9	1	
6Ufe	28.4	1	
6Ufe-6Dyh	5.7	1	

Table 3.4.1 (Continued)

Mapping Unit	Area (ha)	Frequency	Total Area (ha)
6Uga	19.6	2	
6UgaC	2.5	1	
6UgaE	34.8	5	59.7
6Ugc	2.8	1	
6Gna	90.3	4	
6Gnd	96.5	4	
6Gnd2	2.6	1	
6GndE	9.3	1	287.6
6Gne	79.7	5	
6GneE	9.2	1	
6Drc	25.9	7	
6DrcE	0.6	1	26.5
6Dba	53.8	2	
6Dbb	176.3	14	
6Dbb-6Ugc	27.1	1	
6Dbb3	8.1	1	
6DbbE	13.9	2	534.9
6Dbc	4.3	1	
6Dbe	2.8	1	
6DbeE	4.0	1	
6Dbf	93.2	3	
6Dbf2	25.9	3	
6Dbh	123.2	2	
6Dbh2	2.3	1	
6Dyb	6.3	2	
6Dyb2	21.4	1	
6Dyc1-4Dyg	4.2	1	
6Dye	35.1	3	
6Dyf	17.7	2	
6Dyg	51.6	10	
6Dyg3	0.9	1	214.8
6Dyh	27.2	5	
6Dyh2	6.8	1	
6Dyh2-6Dyg2	17.8	1	
6Dyh3	1.8	1	
6DyhE	1.8	1	
6Dyj	22.2	5	
6Dda	65.2	16	
6Dda2	0.5	1	121.4
6Ddb	55.7	5	
6SP	0.9	1	0.9
LU 6	2051.6	155	2051.6
TOTAL	9650.4	765	9650.4

4. SOILS - MORPHOLOGY

A total of 70 soil types as well as variants and phases were identified in the survey area. Table 4.1.1 gives each landscape unit with a brief description of the major distinguishing attributes for the component soil types and vegetation as found in the Leichhardt Downs Section. Detailed morphological descriptions, showing the full range of attributes of these soil types within the Lower Burdekin Valley, are shown in Appendix II. All the attributes in the detailed profile descriptions may not be present in this survey area.

Figure 4.1.1 shows a general relationship between the soils in each landscape unit. A general description of the soils of each landscape unit is as follows:

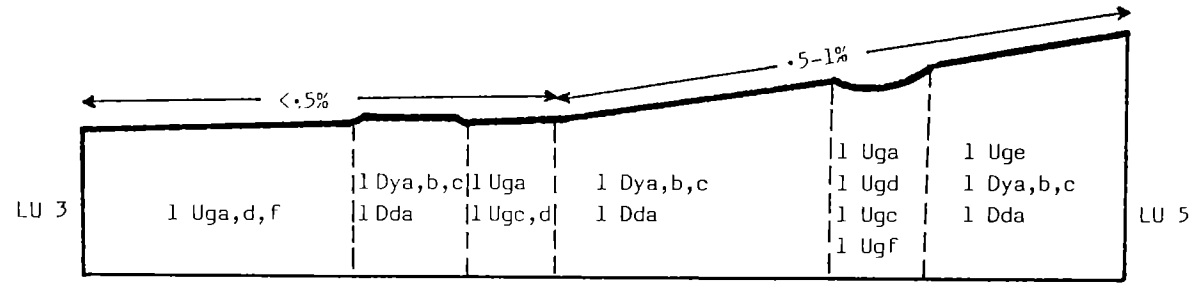
Landscape unit 1. Grey clays and black earths (1Uga,c,d,f) of this landscape unit are located in low lying flats and drainage depressions. The presence of normal gilgai, their position in the landscape and some morphological attributes (bleached A2, 1Ugf; mottled A horizons, 1Ugd and 1Ugc) indicate that these soils are seasonally waterlogged and subjected to local flooding in some situations. Soil type 1Uge is located on pediments on slopes > 1 percent. Linear gilgai is present.

Solodic soils and solodized-solonetz (1Dba, 1Dya, 1Dyb, 1Dyc, 1Dda) are present on pediments between drainage depressions and on slightly elevated flats within the low lying flats. These soil types are usually strongly sodic by 0.3 m, and often have high levels of salt by 0.6 m.

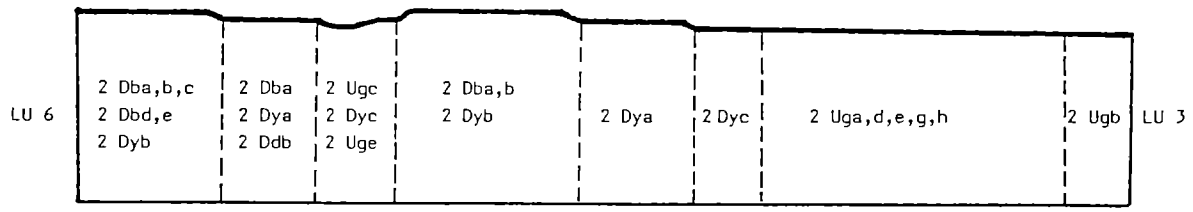
Landscape unit 2. Grey clays with some black earths and soil type 2Dyc (solodic-solodized solonetz) are located in low lying areas and are subjected to seasonal waterlogging and flooding. Soil types 2Uga, 2Ugg and 2Ugh are medium to heavy clay throughout and have self mulching surfaces. In contrast, soil types 2Ugb, 2Ugc, 2Ugd and 2Uge have light to light medium clay A horizons with either hard setting surfaces or weakly developed self mulching characteristics. Soil type 2Ugh is strongly alkaline (pH > 8.5) at and below 0.3 m.

On slightly elevated flats, solodic-solodized solonetz (soil types 2Dba, 2Dbb, 2Dbc, 2Dbe, 2Dya, 2Dyb, 2Ddb) are present. Soil type 2Dya is usually intermediate in elevation in relation to the cracking clays and the other duplex soils. Soils types 2Dba, 2Ddb and 2Dya have thin A horizons (< 0.12 m). In addition, 2Dba and 2Ddb are strongly alkaline (pH > 8.5) and strongly sodic (ESP > 15%) at 0.3 m. Soil types 2Dya is not strongly alkaline at 0.3 m but is often strongly sodic by this depth. Soil types 2Dbb, 2Dbe and 2Dyb have A horizon depths between 0.12 and 0.2 m while those of 2Dbc and 2Dbd may be up to 0.35 m. Soil types 2Dbb and 2Dyb are strongly alkaline (pH > 8.5) at either 0.3 or 0.6 m while soil type 2Dbe only becomes strongly alkaline by 0.9-1.2 m. Soil type 2Dbd becomes strongly alkaline at 0.6 m and 2Dbc at 0.9-1.2 m.

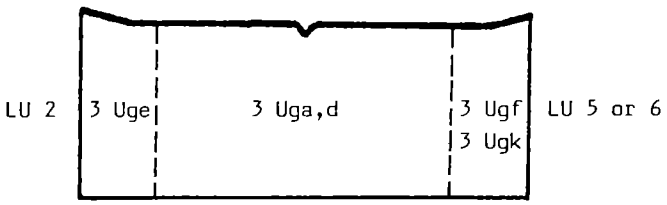
Landscape unit 3. Black earths, soil types 3Uga and 3Ugd, are the dominant soils in this unit. Soil type 3Uge, also a black earth, has similar D horizons to those soils of the Burdekin River alluvial plain



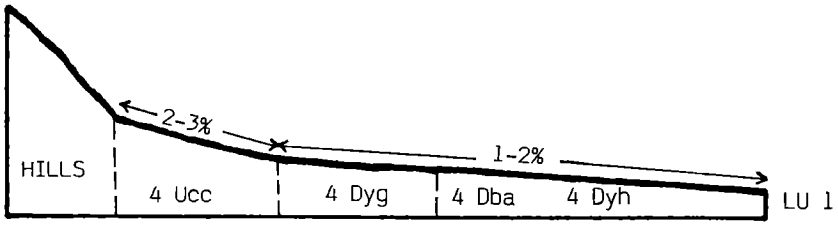
Landscape unit 1



Landscape unit 2

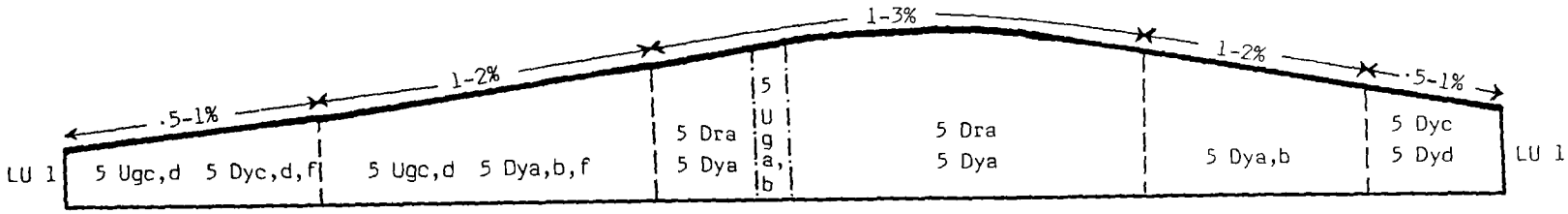


Landscape unit 3

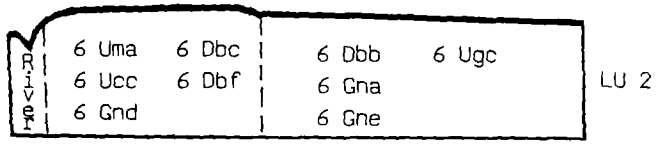


Landscape unit 4

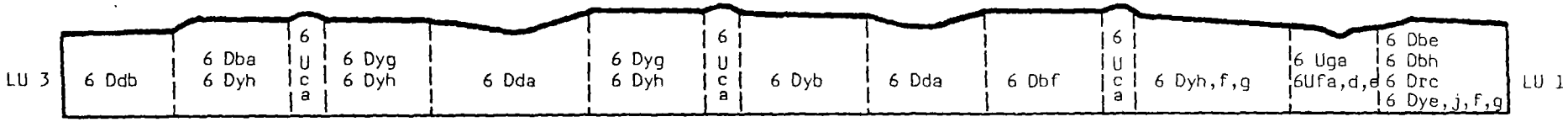
Figure 4.1.1 Diagram showing the relative positions of the soil types of each landscape unit of Leichhardt Downs Section, Burdekin River Irrigation Area.



Landscape unit 5



Landscape unit 6A



Landscape unit 6B

Figure 4.1.1 (continued)

which it adjoins. Soil type 3Uga8 (variant of 3Uga), with significant amounts of small pebbles throughout the profile, borders much of LUs 1 and 6 in the east. A grey clay, 3Ugk, borders part of LU 5 in the north. Soil type 3Ugf with a silty clay A horizon and no gilgai lies adjacent to a creek in the east.

Landscape unit 4. Only pediments and prior streams of LU 4 are present in the south-east of the study area. Soil type 4Ucc with granite in the profile is present on the pediments while solodic-solodized solonetz (4Dba, 4Dyg, 4Dyh) are present on the pediments and prior streams of the area.

Landscape unit 5. Contrasting soils associated with acidic and basic rocks have developed on the mixed geology of landscape unit 5. The soil catena on the gently undulating rises as described by Thompson (1977) consisting of soil types 5Dra and 5Dya on the upper slopes, 5Dyb on the mid to lower slopes and soil type 5Dyc on the lower slopes, does not always exist in the study area. Soil type 5Dra is the dominant soil on the upper slope but it often extends down slope and borders landscape unit 1 in many areas. Soil type 5Dya is a minor soil type associated with 5Dra on the upper and midslopes. Some mid to lower slopes are occupied by the yellow alkaline duplex soil type 5Dyb. Soil types 5Uga and 5Ugb are scattered within areas of soil type 5Dra and are usually developed on basic dykes which have intruded acidic or basic base rock. Larger, more uniform areas of soil type 5Uga are present in the eastern section of the gently undulating rises. A complex soil formation with linear gilgai occurs in limited areas on mid to lower slopes. Solodic-solodized solonetz (5Dyf) have developed on the shelf of the linear gilgai, a black earth in the depression (5Ugc) and a grey clay (5Ugd) on the narrow mound.

Ground water hydrology is considered to have influenced pedogenesis in some areas of LU 5 (Thompson 1980). Lower slope positions and areas adjacent to dykes which have intruded in a direction across the slope are often occupied by solodic-solodized solonetz (soil type 5Dyc). Restrictions to the seasonal downslope movement of the groundwater in these positions may have caused upward water movement in the soil profile with subsequent accumulation of salts by evapotranspiration. Soil type (5Dyd) is of minor occurrence developed in similar positions.

Landscape unit 6. This landscape unit has been divided into the Burdekin River alluvial landform and Creek and relict alluvial landforms. Some soil types occur on both landforms. They are listed on the map under the landform on which they are most common.

On the Burdekin River alluvial landform, uniform, gradational and duplex soils (6Ucc, 6Uma, 6Gnd, 6Dbc and 6Dbf) with neutral soil reaction trend (Northcote 1979) have developed on the present levee of the Burdekin River. Soil types (6Ugc, 6Gne and 6Dbb) with an alkaline soil reaction trend, as well as 6Umb2 and 6Uma, are present on the backplain between the current levee and the Burdekin River alluvial plain.

On the creek and relict alluvial landforms a complex distribution of soils, developed from alluvia deposited from the ranges and hills to the

south-east of the study area, is present on floodouts, fans and prior streams. These soils range from uniform sands (6Uca) of prior streams to the podzolic soils (6Dbf), soloths (6Dyb) and solodic-solodized solonetz (6Dye, 6Dyf, 6Dyg, 6Dyh, 6Dda and 6Ddb) of the floodouts, fans and closed depressions. Textures of the A horizons range from sand to clay loam and thickness varies considerably. Contrasting D horizons of sand to clay texture also occur.

A 0.2-0.5 km wide zone of soils (6Ufa, 6Uga, 6Dyg, 6Dyj, 6Dda) are developed from alluvial deposits along Stokes Creek and the lower reaches of One Mile and Cassidy Creek. An alluvial soil, 6Ufe, occurs along the locally named Sheep Camp Creek.

The variation between the soils of the relict levees (6Dbh, 6Drc and 6Dbb) is much less than that of the floodouts and fans. A greater proportion of fine sand is also found in these profiles. Soil type (6Dbh) is strongly sodic from shallow depths (< 0.3 m).

Table 4.1.1 Landscape units and major distingushing attributes of the soil types, Leichhardt Downs, Section, Burdekin River Irrigation Area.

Landscape unit	Landform element	Soil type	Major distingushing attributes	Great soil group	PPF	Predominant natural vegetation
Local alluvial plains and associated pediments	Low lying flats and drainage depressions	1Uga	0.02 m moderate self mulch over dark to grey medium clay to 0.05 - 0.15 m over alkaline dark to grey medium to heavy clay to 1.5+m, moderate to strong gilgai	Black earth - grey clay	Ug5.16 Ug5.24	Low open woodland of poplar gum and carbeen with cabbage gum, beefwood and broad leaf tea-tree associated with Tussock grassland of cane grass and blue grasses
		1Ugc	Hard setting surface over brown-mottled dark light to light medium clay to 0.05 0.10 m A1 horizon frequently over bleached A2 horizon to 0.08 - 0.15 m over alkaline dark to grey medium to heavy clay to 1.5+m, weak gilgai	Black earth - (bleached) black earth - (bleached) grey clay	Ug5.16 Ug2 Ug3.1	Low open woodland of poplar gum and cabbage gum with carbeen, beefwood and broad leaf tea-tree associated with Tussock grassland of blue grasses, brown top and cane grass
		1Ugd	0.02 weak self mulch over brown-mottled grey light medium to medium clay to 0.05 - 0.15 m over alkaline grey to yellow-grey medium to heavy clay to 1.5+m, weak to moderate gilgai	Grey clay	Ug5.28 Ug5.24	Low open woodland of poplar gum and carbeen with cabbage gum and beefwood associated in poorly drained areas with Tussock grassland of blue grasses and cane grass with brown top and black spear grass associated.
		1Ugf	Weakly self mulching to hard setting surface over grey to dark light to light medium clay A1 horizon to 0.05 - 0.15 m over bleached A2 horizon to 0.15 - 0.30 m over grey medium clay to 0.40 - 0.80 m over alkaline grey to yellow-brown medium to heavy clay to 1.5+m, weak to moderate gilgai	(Bleached) grey clay	Ug3.2 Ug2	Low open woodland of poplar gum and cabbage gum with carbeen, beefwood and broad leaf tea-tree associated with Tussock grassland of blue grasses, black spear grass and brown top
	Pediments with linear gilgai	1Uge	Depression: Weakly self mulching to hard setting surface over dark to grey light to light medium clay to 0.10 - 0.20 m over alkaline dark to grey medium clay to 0.45 - 0.80 m over yellow-brown to grey medium clay to 1.5+m	Black earth-grey clay	Ug5.16 Ug5.24	Low open woodland of poplar gum and cabbage gum with beefwood associated with Tussock grassland cane grass, black spear grass and blue grasses
			Mound: 0.02 m moderate self mulch over grey light to medium clay to 0.05 - 0.15 m over yellow-brown to grey medium clay to 1.5+m	Grey clay	Ug5.24 Ug5.28	

Table 4.1.1. (Continued)

Landscape unit	Landform element	Soil type	Major distingushing attributes	Great soil group	PPF	Predominant natural vegetation
Local alluvial plains and associated pediments	Pediments and slightly elevated flats	1Dba	0.05 - 0.15 m brown to dark clay loam A horizon bleached throughout or near base over alkaline brown medium to heavy clay B horizon to 0.35 - 0.40 m over strongly alkaline yellow-brown light medium clay D horizon to 1.5+m	Solodic-solodized solonetz	Db1.33 Db1.43	Low open woodland of cabbage gum and beefwood with false sandalwood and broad leaf tea-tree associated with Open tussock grassland of blue grasses and black spear grass
		1Dya	0.05 - 0.10 m grey sandy clay loam to clay loam A horizon bleached throughout or near base over alkaline grey medium clay B horizon to 0.50 - 0.90 m over strongly alkaline grey to brown medium clay B horizon to 1.5+m	Solodic-solodized solonetz	Dy2.43 Dy2.33	Low to tall shrubland of false sandalwood and beefwood or Low open woodland of cabbage gum, poplar gum and scattered false sandalwood with Open tussock grassland of black spear grass and blue grasses
		1Dyb	0.10 - 0.15 m dark to brown sandy loam to clay loam A horizon bleached throughout or near base over alkaline grey light to light medium clay B horizon to 0.40 - 0.60 m over strongly alkaline yellow-brown to light grey sandy clay loam to sandy clay D horizon to 1.5+m	Solodic-solodized solonetz	Dy2.33 Dy2.43	Low woodland to low open woodland of cabbage gum, poplar gum, carbeen, beefwood and false sandalwood with Tussock grassland of black spear grass and blue grasses
		1Dyc	0.05 - 0.10 m brown-mottled dark to brown clay loam A1 horizon over bleached A2 horizon to 0.10 - 0.15 m over alkaline grey medium to heavy clay B horizon to 0.40 0.80 m over strongly alkaline grey to yellow-brown medium clay B horizon to 1.5+m	Solodic-solodized solonetz	Dy2.43 Dy2.33	Low open woodland of cabbage gum, poplar gum and beefwood with carbeen and false sandalwood associated with Tussock grassland of blue grasses and black spear grass
		1Dda	0.05 - 0.10 m brown-mottled dark to grey clay loam A1 horizon over bleached A2 horizon to 0.10 - 0.15 m over alkaline dark medium to heavy clay B horizon to 0.60 - 1.20 m over grey light to medium clay B or D horizon to 1.5+m	Solodic-solodized solonetz	Dd1.43 Dd1.33	Low open woodland of poplar gum and carbeen with cabbage gum, beefwood and willow wattle associated with Tussock grassland of black spear grass and blue grasses with kangaroo grass associated

Table 4.1.1. (Continued)

Landscape unit	Landform element	Soil type	Major distingushing attributes	Great soil group	PPF	Predominant natural vegetation
Burdekin River alluvial plain	Low lying flats	2Uga	0.01 - 0.02 m weak to moderate self mulch over grey to dark medium to heavy clay to 0.05 - 0.10 m over alkaline grey to dark medium to heavy clay to 1.00 - 1.35 m over brown medium to heavy clay to 1.5+m, weak gilgai	Grey clay - black earth	Ug5.25 Ug5.29 Ug5.15	Low open woodland to low woodland of carbeen and poplar gum with broad leaf tea-tree and beefwood associated with Tussock grassland of cane grass and blue grasses
		2Ugb	0.01 - 0.02 m weak to moderate self mulch over dark to grey light to light medium clay to 0.05 - 0.10 m over alkaline dark to grey medium to heavy clay to 0.75 - 1.00 m over brown light to medium clay D horizon to 1.5+m, weak gilgai	Black earth - grey clay	Ug5.17 Ug5.7	Low open woodland of poplar gum and carbeen with broad leaf tea-tree associated with Tussock grassland of cane grass and blue grasses
		2Ugc	Weakly self mulching to hard setting surface over brown-mottled dark to grey light to light medium clay to 0.05 - 0.10 m over alkaline grey medium to heavy clay to 1.5+m weak to moderate gilgai	Grey clay	Ug5.28 Ug5.29	Low open woodland to low woodland of poplar gum with cabbage gum, carbeen, broad leaf tea-tree and beefwood associated with Tussock grassland of cane and blue grasses
		2Ugd	Weakly self mulching to hard setting surface over bleached brown-mottled grey light to light medium clay to 0.10 - 0.25 m over brown-mottled grey medium to heavy clay to 1.00 - 1.20 m over yellow-brown to grey light to medium clay to 1.5+m, strongly alkaline at and below 0.90 - 1.20 m, moderate to strong gilgai	(Bleached) grey clay	Ug3.2 Ug2	Low open woodland to low woodland or occasionally woodland of poplar gum and carbeen with broad leaf tea-tree associated with Tussock grassland of blue grasses, kangaroo grass and black spear grass
		2Uge	Weakly self mulching to hard setting surface over occasionally bleached brown-mottled dark to grey light to light medium clay to 0.05 - 0.25 m over brown-mottled grey medium to heavy clay to 0.80 - 1.30 m over brown to grey light to medium clay to 1.5+m strongly alkaline above or at 0.60 m weak to moderate gilgai	Grey clay - (bleached) grey clay	Ug5.59 Ug5.25 Ug5.28 Ug3.2	Low open woodland to low woodland of poplar gum with carbeen and cabbage gum associated with Tussock grassland of blue grasses, black spear grass and kangaroo grass

Table 4.1.1. (Continued)

Landscape unit	Landform element	Soil type	Major distingushing attributes	Great soil group	PPF	Predominant natural vegetation
Burdekin River alluvial plain	Low lying flats	2Ugg	0.01 - 0.02 m moderate self mulch over grey medium to heavy clay to 0.10 - 0.20 m over grey medium to heavy clay to 1.20 - 1.40 m over yellow-brown to grey medium to heavy clay to 1.5+m, strongly alkaline at and below 0.60 - 0.90 m, moderate to strong gilgai	Grey clay	Ug5.29 Ug5.24 Ug5.28	Low open woodland to low woodland of poplar gum with carbeen and broad leaf tea-tree associated with Tussock grassland of blue grasses and cane grass
		2Ugh	0.01 - 0.02 m moderate self mulch over brown-mottled grey medium to heavy clay to 0.10 - 0.15 m over grey medium to heavy clay to 1.5+m, strongly alkaline at and below 0.30 m, moderate to strong gilgai	Grey clay	Ug5.28 Ug5.24	Isolated trees to low open woodland of carbeen, poplar gum and cabbage gum with Tussock grassland of blue grasses, cane grass and Flinders grass
		2Dyc	0.05 - 0.10 m brown-mottled dark to grey loam A1 horizon over bleached A2 horizon to 0.12 - 0.25 m over alkaline brown-mottled grey medium to heavy clay B horizon to 1.10 - 1.30 m over grey to yellow-brown light to medium clay D horizon to 1.5+m, moderate to strong gilgai	Solodic-solodized solonetz	Dy3.33 Dy3.43	Low open woodland to open woodland of poplar gum and cabbage gum with Tussock grassland of blue grasses, black spear grass and kangaroo grass
	Slightly elevated flats	2Dba	0.03 - 0.05 m brown clay loam A1 horizon over bleached A2 horizon to 0.05 - 0.10 m over brown medium clay B horizon to 1.00 - 1.5+m over brown sandy clay to light- medium clay D horizon to 1.5+m, strongly alkaline and at below 0.30 m	Solodic-solodized solonetz	Db1.43 Db1.33	Low to tall shrubland of false sandalwood and beefwood with cabbage gum, poplar gum and carbeen associated with Open to sparse tussock grassland of blue grasses, black spear grass, purple top Rhodes grass and button grass
		2Dbb	0.05 - 0.15 dark to brown clay loam A1 horizon over bleached A2 horizon to 0.12 0.20 m over brown medium clay B horizon to 1.20 - 1.5+m over brown sandy clay to light medium clay D horizon to 1.5+m, strongly alkaline above or at 0.60 m	Solodic-solodized solonetz	Db1.33 Db1.43	Low open woodland of poplar gum, carbeen and cabbage gum with beefwood and mimosa associated with Tussock grassland of purple top Rhodes grass, black spear grass and blue grasses

Table 4.1.1. (Continued)

Landscape unit	Landform element	Soil type	Major distingushing attributes	Great soil group	PPF	Predominant natural vegetation
Burdekin River alluvial plain	Slightly elevated flats	2Dbc	0.05 - 0.20 m brown-mottled dark to grey loam to clay loam A1 horizon over bleached A2 horizon to 0.20 - 0.35 m over brown-mottled grey to brown medium clay B horizon to 1.00 - 1.5+m over brown sandy clay to light medium clay D horizon to 1.5+m, strongly alkaline at and below 0.90 - 1.20 m	Solodic-solodized solonetz	Dy3.43 Dy3.33 Db2.43 Db2.33	Low open woodland to low woodland of poplar gum, carbeen and cabbage gum with Tussock grassland of black spear grass, blue grasses and kangaroo grass
		2Dbd	0.10 - 0.20 m dark to brown loam to fine sandy clay loam A1 horizon over bleached A2 horizon to 0.20 - 0.35 m over grey to brown medium to heavy clay B horizon to 0.70 - 1.00 m over brown light to medium clay D horizon to 1.5+m, strongly alkaline at and below 0.60 m	Solodic-solodized solonetz	Dy2.43 Dy2.33 Db1.43 Db1.33	Low open woodland to woodland of cabbage gum, carbeen and poplar gum with Tussock grassland of black spear grass, blue grasses and kangaroo grass
		2Dbe	0.05 - 0.10 m brown-mottled dark to grey loam to clay loam A1 horizon over bleached A2 horizon to 0.12 - 0.20 m over red-mottled brown medium to heavy clay B horizon to 1.15 - 1.25 m over brown light to medium clay D horizon to 1.5+m, strongly alkaline at and below 0.90 - 1.20 m	Solodic-solodized solonetz	Db2.43 Db2.33	Low open woodland to open woodland of poplar gum, cabbage gum and carbeen with beefwood associated with Tussock grassland of black spear grass, blue grasses and kangaroo grass
		2Dya	0.05 - 0.10 m brown-mottled dark to brown clay loam A horizon bleached throughout or near base over grey medium to heavy clay B horizon to 0.90 - 1.5+m over brown sandy clay to light medium clay D horizon to 1.5+m, strongly alkaline at and below 0.60 m	Solodic-solodized solonetz	Dy2.33 Dy2.43	Low open woodland to woodland of poplar gum, cabbage gum and carbeen with beefwood and broad leaf tea-tree associated with Tussock grassland of blue grasses and kangaroo grass
		2Dyb	0.05 - 0.10 m brown-mottled dark grey to brown loam to clay loam A1 horizon over bleached A horizon to 0.12 - 0.20 m over grey medium to heavy clay B horizon to 0.90 - 1.5+m over brown light to medium clay D horizon to 1.5+m, strongly alkaline above or at 0.60 m	Solodic-solodized solonetz	Dy2.33 Dy2.43	Low open woodland of cabbage gum and poplar gum with beefwood associated with Tussock grassland of black spear grass, blue grasses and purple top Rhodes grass

Table 4.1.1. (Continued)

Landscape unit	Landform element	Soil type	Major distingushing attributes	Great soil group	PPF	Predominant natural vegetation
Burdekin River alluvial plain	Slightly elevated flats	2Ddb	0.05 - 1.2 m brown-mottled dark to grey loam to clay loam A1 horizon bleached throughout or near base over dark to grey medium to heavy clay B horizon to 0.65 - 1.00 m over brown light to medium clay D horizon to 1.5+m, strongly alkaline at and below 0.30 m	Solodic-solodized solonetz	Dd1.33 Dy2.33 Dd1.43	Low open woodland of beefwood, cabbage gum and poplar gum or low to tall shrubland of false sandalwood and beefwood with Open tussock grassland of black grass grass, blue grasses, purple top Rhodes grass and kangaroo grass
Local alluvial plain	Plain	3Uga	0.02 moderate medium self mulch over dark heavy clay to 0.90 - 1.20 m over grey heavy clay to 1.5+m, strongly alkaline above or at 0.60, carbonate present above or at 0.75 m, moderate to strong gilgai	Black earth	Ug5.16	Tussock grassland of cane grass and blue grass
		3Ugd	0.02 strong coarse self mulch over dark heavy clay to 0.75 to 1.20 m over grey heavy clay to 1.5+m, strongly alkaline at or below 0.90 m, carbonate present below 0.75 m, moderate to strong gilgai	Black earth	Ug5.16	Tussock grassland of cane grass and blue grasses with brown top and Flinders grass associated
		3Uge	0.02 m weak self mulch over brown-mottled dark medium clay to 0.10 - 0.15 m over alkaline dark heavy clay to 0.90 - 1.20 m over brown light to medium clay D horizon to 1.5+m, weak to moderate gilgai	Black earth	Ug5.17	Tussock grassland of cane grass and blue grasses
		3Ugf	0.01 - 0.02 m weak self mulch over dark silty clay to 0.10 - 0.30 m over alkaline dark medium clay to 0.80 - 1.00 m over dark to grey medium to heavy clay to 1.5+m	Black earth	Ug5.1 Ug5.16	Low open woodland of carbeen and poplar gum with grey bloodwood associated with Tussock grassland of blue grasses, Rhodes grass, black spear grass and cane grass
	Plain margins bordering other landscape units	3Ugk	0.01 - 0.02 m weak to moderate self mulch over brown-mottled grey medium clay to 0.10 - 0.15 m over alkaline grey to yellow-grey medium clay to 1.20 - 1.5m over yellow light medium to medium clay 2BC horizon to 1.5+m, moderate to strong gilgai	Grey clay	Ug5.2 Ug5.28	Low open woodland of poplar gum and carbeen with broad leaf tea-tree associated with Tussock grassland of cane grass and blue grasses with para grass associated

Table 4.1.1. (Continued)

Landscape unit	Landform element	Soil type	Major distinguishing attributes	Great soil group	PPF	Predominant natural vegetation
Gently undulating rises on acid intrusive rocks, pediments and prior streams	Pediments	4Ucc	0.10 - 0.30 m dark to brown coarse sand to sandy loam A1 horizon over bleached A2 horizon to 0.40 - 0.90 m over acid grey to yellow-brown coarse sand to sandy loam B horizon to 1.00 - 1.5+m, over coarse sand or hard rock to 1.5+m.	No suitable group, affinities with podzol	Uc2.12 Uc2.21	Woodland to low woodland of cabbage gum, poplar gum and grey bloodwood with quinine bush and broad leaf tea-tree associated with Open tussock grassland of black spear grass and giant spear grass
	Pediments and prior streams	4Dba	0.05 - 0.02 m brown sandy loam to sandy clay loam A1 horizon over bleached A2 horizon to 0.20 - 0.25 m over alkaline brown medium clay B horizon to 0.45 - 1.5+m, over coarse sand D horizon to 1.5+m	Solodic-solodized solonetz	Db1.43 Db1.33	Open woodland of poplar gum, grey ironbark, red bloodwood and cabbage gum with beefwood associated with Open tussock grassland of giant spear grass, black spear grass, wire grass and blue grasses
		4Dyg	0.10 - 0.20 m dark to yellow-brown loam to clay loam A1 horizon over bleached A2 horizon to 0.15 - 0.30 m over grey to yellow-brown medium clay B horizon to 0.80 - 1.5+m over sandy clay to light clay D horizons or rock, alkaline at and below 0.60 m	Solodic-solodized solonetz	Dy2.33 Dy2.43	Low open woodland to woodland of cabbage gum, grey ironbark, poplar gum and broad leaf tea-tree with bulloak and false sandalwood associated with Tussock to open tussock grassland of black spear grass, kangaroo and blue grasses with wire grass and purple top Rhodes grass associated
		4Dyh	0.10 - 0.20 m dark to grey light sandy clay loam to clay loam A1 horizon over bleached A2 horizon to 0.15 - 0.30 m over brown-mottled grey medium clay B horizon to 0.75 1.5+m over gravelly sandy clay to light clay D horizon or rock, alkaline at and below 0.30 m	Solodic-solodized solonetz	Dy3.43 Dy3.33	Low open woodland to woodland of carbeen, cabbage gum and broad leaf tea-tree with beefwood, grey ironbark and false sandalwood associated with Open tussock grassland of purple top Rhodes grass, love grass, wire grass and blue grasses

Table 4.1.1 (Continued)

Landscape unit	Landform element	Soil type	Major distingushing attributes	Great soil group	PPF	Predominant natural vegetation
Gently undulating rises on an intrusive rock complex	No fixed slope position	5Uga	0.02 moderate to strong self mulch over dark medium to heavy clay to 0.05 - 0.12 m over alkaline dark to grey medium to heavy clay to 0.70 - 1.00 m over decomposing rock	Black earth	Ug5.12 Ug5.14	Isolated trees to low open woodland of cabbage gum, grey ironbark and poplar gum with carbeen associated with Tussock grassland of blue grasses, cane grass and Rhodes grasses Occasionally only grassland present
Gently undulating rises on an intrusive rock complex	No fixed slope position	5Ugb	Weakly self mulching to hard setting surface over grey to dark light to light medium clay A1 horizon to 0.10 - 0.20 m occasionally over bleached A2 to 0.15 - 0.25 m, over alkaline grey to dark medium clay to 0.40 - 0.80 m over grey to yellow-brown medium clay to 0.70 - 1.0 m over decomposing rock	Grey clay - black earth - (bleached) grey clay	Ug5.22 Ug5.14 Ug3.2	Isolated trees to low open woodland of cabbage gum and poplar gum with grey ironbark and grey and red bloodwood associated with Tussock grassland of black spear grass blue grasses and cane grass
	Upper and mid slopes	5Dra	0.15 - 0.30 m dark to brown clay loam A horizon over acid to neutral red medium clay to 0.70 - 1.20 m over decomposing rock	Non-calcic brown soil	Dr2.12 Dr2.11	Low open woodland to low woodland of grey ironbark and red bloodwood with poplar gum and grey bloodwood associated with Tussock grassland of black spear grass, giant spear grass, kangaroo grass and blue grasses
		5Dya	0.15 - 0.25 m dark to brown sandy clay loam to clay loam A horizon over acid to neutral yellow-brown medium clay to 0.70 - 1.00 m over decomposing rock	No suitable group, yellow equivalent of non-calcic brown soil	Dy2.12 Dy2.11	Low open woodland to low woodland of poplar gun, red bloodwood and grey ironbark with carbeen and grey bloodwood associated with Tussock grassland of black spear grass, giant spear grass and kangaroo grass
	Mid to lower slopes	5Dyb	0.10 - 0.20 m dark to brown clay loam A horizon over alkaline yellow-brown light medium to medium clay to 0.90 - 1.30 m over decomposing rock	No suitable group	Dy2.13	Low open to low woodland of poplar gum, cabbage gum and grey bloodwood with scattered beefwood, red bloodwood and grey ironbark associated with Tussock grassland of black spear grass, giant spear grass, kangaroo grass and blue grasses

Table 4.1.1 (Continued)

Landscape unit	Landform element	Soil type	Major distinguishing attributes	Great soil group	PPF	Predominant natural vegetation
Gently undulating rises on an intrusive rock complex	Mid to lower slopes	5Dyf-5Ugc	Linear gilgai complex with self, depression and narrow mound			Low open woodland of cabbage gum and poplar gum with Tussock grassland to open tussock grassland of black spear grass, blue grasses, and cane grass with kangaroo grass, brown top and Panicum spp. associated
			Shelf: (5Dyf 0.10 - 0.15 m grey clay loam A1 horizon over bleached A2 horizon to 0.15 - 0.20 m over alkaline grey medium clay B horizon to 0.80 - 1.10 m over decomposing rock	Solodic-solodized solonetz	Dy2.43 Dy2.33	
			Depression: (5Ugc) Weakly self mulching to hard setting surface over dark light to light medium clay A1 horizon to 0.10 - 0.15 m occasionally over bleached A2 horizon to 0.15 - 0.20 m over alkaline dark medium clay to 0.50 - 0.90 m over grey to brown medium clay to 0.90 - 1.10 m over decomposing rock	Black earth - (bleached) black earth	Ug5.14 Ug3.1 Ug5.13	
	Lower slopes	5Dyc	0.10 - 0.20 m brown-mottled dark to brown sandy clay loam to clay loam A1 horizon over bleached A2 horizon to 0.15 - 0.30 m over alkaline grey medium clay B horizon to 0.40 - 1.20 m over grey to yellow-grey medium clay to 0.80 - 1.50 m over decomposing rock or colluvia	Solodic-solodized solonetz	Dy2.43 Dy2.33	Low open woodland of cabbage gum, poplar gum and beefwood with carbeen associated with Tussock to open tussock grassland of black spear grass, Rhodes grass and blue grasses with wire grass associated
	Lower slopes	5Dyd	0.05-0.10 m dark to grey sandy to clay loam to clay loam A1 horizon over bleached A2 horizon to 0.10 -0.12 m over strongly alkaline grey to yellow-brown medium clay B horizon to 0.70 - 1.20 m over decomposing rock or colluvia	Solodic-solodized solonetz	Dy2.43 Dy2.33	Low open woodland of cabbage gum and poplar gum with false sandalwood and beefwood associated or Tall shrubland to tall open shrubland of false sandalwood with Open tussock grassland of black spear grass Rhodes grass and blue grasses

Table 4.1.1 (Continued)

Landscape unit	Landform element	Soil type	Major distinguishing attributes	Great soil group	PPF	Predominant natural vegetation
Miscellaneous alluvial landforms A. Burdekin River alluvial landforms	Levee	6Ucc	0.05 - 0.50 m dark to brown sand to fine sandy loam A1 horizon over grey, brown or yellow A12 or A2 horizon to 0.50 - 1.10 m over acid to neutral brown to yellow sand to sandy clay loam A3 or B horizon to 1.5+m	No suitable group, affinities with siliceous sand-earthy sand	Uc5.21 Uc5.11 Uc5.23 Uc4.22	Open woodland to open forest of poplar gum, carbeen, grey bloodwood and Burdekin plum with broad leaf tea-tree, cocky apple, pandanus, prickly pine and quinine bush associated with Tussock grassland of giant spear grass, black spear grass and brown sorghum with golden beard grass and blue grasses associated
		6Uma	0.15 - 0.40 m dark to brown sandy loam to clay loam A horizon over acid to neutral brown sandy loam to clay loam B horizon to 0.80 - 1.10 m over brown sandy loam to sandy clay loam D horizon to 1.5+m	No suitable group, affinities with yellow earth	Um5.52 Gn2.22 Gn2.41 Uc5.22	Woodland to low open woodland of carbeen, poplar gum and grey bloodwood with batswing coral tree, cocky apple Burdekin plum and Leichhardt tree associated with Tussock grassland of black spear grass, giant spear grass, and brown sorghum
		6Gnd	0.15 - 0.30 m grey to brown sandy loam to clay loam A1 horizon over brown to yellow-brown fine sandy loam to clay loam A2 or A3 horizon to 0.50 - 1.20 m over neutral brown to yellow clay loam to light clay B horizon to 1.5+m	No suitable group, affinities with yellow podzolic soil	Gn3.75 Gn3.72 Gn3.22	Woodland to open woodland of carbeen, cabbage gum and poplar gum with red and grey bloodwood and cocky apple associated with Tussock grassland of black spear grass, giant spear grass and brown sorghum
		6Dbc	0.10 - 0.20 m dark to brown fine sandy loam to fine sandy clay loam A1 horizon over frequently bleached A2 horizon to 0.20 - 0.40 m over neutral brown medium clay B horizon to 0.90 - 1.5+m over brown to grey sandy loam to light medium clay D horizon to 1.5+m	No suitable group, affinities with brown podzolic soil	Db1.32 Db1.22	Woodland to low woodland of poplar gum, grey bloodwood and carbeen with cocky apple associated with Tussock grassland of black spear grass giant spear grass, brown sorghum and kangaroo grass

Table 4.1.1 (Continued)

Landscape unit	Landform element	Soil type	Major distingushing attributes	Great soil group	PPF	Predominant natural vegetation
Miscellaneous alluvial landforms A. Burdekin River alluvial landforms	Levee	6Dbf	0.05 - 0.25 m dark to brown sandy loam to loam fine sandy A1 horizon over yellow-brown to grey fine sandy loam to fine sandy clay loam A2 or A3 horizon to 0.20 - 0.40 m over neutral brown to yellow-brown fine sandy clay to medium clay B horizon to 0.80 - 1.40 m over sandy clay loam to fine sandy clay D horizon to 1.5+m	Brown podzolic soil	Db1.22 Db1.12 Dy2.12	Open woodland to woodland of poplar gum, grey and red bloodwood, carbeen and grey ironbark with cocky apple associated with Tussock grassland of blue grasses, black spear grass and giant spear grass with golden beard grass associated
	Backplain	6Umb2	0.02 - 0.30 m dark to grey loam fine sandy to fine sandy clay loam A horizon over acid to neutral dark to yellow-brown clay loam to light clay B horizon to 0.55 - 0.75 m over neutral brown to grey fine sandy clay loam to medium clay D horizons to 1.5+m	No suitable group	Um5.52 Um6.31 Gn3.91	Woodland of poplar gum, grey bloodwood and carbeen with cocky apple associated with Tussock grassland of brown sorghum, black spear grass and giant spear grass
	Backplain	6Ugc	Hard setting surface over brown-mottled dark to grey light clay A1 horizon to 0.10 - 0.20 m over bleached A2 horizon to 0.15 - 0.30 m over alkaline grey medium clay B horizon to 0.75 - 1.5+m over grey to brown light clay D horizon to 1.5+m	(Bleached) grey clay No suitable group	Ug2 Ug3.2 Uf3	Low open woodland of low woodland of cabbage gum, poplar gum and carbeen with cocky apple associated with Tussock grassland of blue grasses, kangaroo grass and black spear grass
		6Gna	0.20 - 0.40 m dark clay loam A horizon over neutral brown to dark light to medium clay B horizon to 0.90 - 1.20 m over brown sandy clay loam to sandy clay D horizon to 1.5+m	No suitable group, affinities with prairie soil	Gn3.22 Gn3.92 Gn3.42 Dd1.12	Low open woodland to low woodland of carbeen, cabbage gum, poplar gum and grey bloodwood with coral tree, Leichhardt tree and cocky apple associated with Tussock grassland of giant spear grass, black spear grass and brown sorghum
		6Gne	0.15 - 0.35 m dark to grey clay loam A1 horizon over bleached A2 horizon to 0.25 - 0.50 m over alkaline dark to grey light clay B horizon to 1.5+m	No suitable group	Gn3.49 Gn3.03 Gn3.06	Low open woodland to open woodland of poplar gum and cabbage gum with grey bloodwood and cocky apple associated with Tussock grassland of black spear grass and giant spear grass with blady grass and brown sorghum associated

Table 4.1.1 (Continued)

Landscape unit	Landform element	Soil type	Major distingushing attributes	Great soil group	PPF	Predominant natural vegetation
Miscellaneous alluvial landforms A. Burdekin River alluvial landforms	Backplain	6Dbb	0.10 - 0.25 m dark to brown loam to clay loam A1 horizon over bleached A2 horizon to 0.30 - 0.40 m over alkaline grey to brown or dark medium clay B horizon to 1.00 - 1.20 m over brown to yellow-brown light to light medium clay D horizon to 1.5+m	Solodic soil	Dy2.43 Dy2.33 Db1.33 Dd1.33	Low open woodland to low woodland of poplar gum, cabbage gum, carbeen and grey bloodwood with cocky apple associated with Tussock grassland of black spear grass, giant spear grass and brown sorghum
Miscellaneous alluvial landforms B. Creek and relict alluvial landforms	Prior stream	6Uca	0.10 - 0.30 m dark coarse sand to sandy loam A horizon over acid to neutral brown coarse sand to sandy loam to 0.80 - 1.00 m over mottled sand D horizon to 1.5+m	No suitable group affinities with earthy sands	Uc5.11 Uc5.21	Low open to low woodland of pandanus, broad leaf tea-tree and grey bloodwood with cocky apple and poplar gum associated with Tussock grassland of giant spear grass and black spear grass
	Levee	6Uga	Hard setting to weakly self mulching surface over dark light to light medium clay to 0.05 - 0.20 m over alkaline dark to grey medium clay to 1.00 - 1.5+m over grey sandy clay to medium clay D horizon to 1.5+m	Black earth-grey clay	Ug5.17 Ug5.15 Ug5.2	Open woodland to woodland of poplar gum, cabbage gum and grey bloodwood with carbeen and red bloodwood associated with Tussock grassland of black spear grass and blue grasses
		6Drc	0.10 - 0.20 m dark to grey loam to clay loam A1 horizon over bleached A2 horizon to 0.20 - 0.50 m over alkaline yellow-mottled red to brown medium to heavy clay B horizon to 1.00 - 1.35 m over red-brown sandy clay to medium clay D horizon to 1.5+m	Solodic-solodized solonetz	Dr3.33 Dr3.43	Open woodland to woodland of grey bloodwood and poplar gum with carbeen, cabbage gum, cocky apple and beefwood associated with Tussock grassland of black spear grass blue grasses and giant spear grass with kangaroo grass associated
		6Dbe	0.05 - 0.15 m brown-mottled dark to brown fine sandy loam to fine sandy clay loam A1 horizon over bleached A2 horizon to 0.10 - 0.20 m over neutral to alkaline yellow-mottled brown medium to heavy clay B horizon to 0.55 - 0.70 m over brown to yellow-brown loamy sandy to light medium clay D horizons to 1.5+m	Red-brown earth	Db2.33 Db2.43 Db2.32	Open woodland to open forest of poplar gum, carbeen and red and grey bloodwood with beefwood and cocky apple associated. Occasionally open forest of tea-tree with Tussock grassland of blue grasses, black spear grass and golden beard grass

Table 4.1.1 (Continued)

Landscape unit	Landform element	Soil type	Major distinguishing attributes	Great soil group	PPF	Predominant natural vegetation
Miscellaneous alluvial landforms B. Creek and relict alluvial landforms	Floodouts, fans and levees	6Dyb	0.15 - 0.30 m dark to brown sandy loam A1 horizon over bleached A2 horizon to 0.30 - 0.60 m over neutral yellow-mottled yellow-brown sandy clay to medium clay B horizon to 1.5+m	Soloth-solodic soil	Dy3.32 Dy3.42	Open woodland of poplar gum and grey bloodwood with carbeen, cocky apple and cabbage gum associated with Tussock grassland of black spear grass, blue grasses and giant spear grass
		6Dye	0.20 - 0.40 m dark to brown loamy sand to sandy loam A1 horizon over bleached A2 horizon to 0.30 - 0.80 m over alkaline yellow-mottled grey to yellow-brown medium clay B horizon to 1.5+m	Solodic-solodized solonetz	Dy3.43 Dy3.33	Open woodland to low open woodland of poplar gum, grey bloodwood and tea-tree spp. with beefwood and cabbage gum associated with Tussock grassland of black spear grass and giant spear grass
		6Dyf	0.10 - 0.25 m grey to dark loam to clay loam A1 horizon over bleached A2 horizon to 0.25 - 0.50 m over alkaline brown-mottled yellow-brown to brown medium clay B horizon to 1.20 - 1.50+m over brown light to light medium clay D horizon to 1.5+m	Solodic-solodized solonetz	Dy3.43 Dy3.33 Db2.43	Woodland to low woodland of poplar gum and grey bloodwood with cocky apple associated with Tussock grassland of black spear grass, giant spear grass and kangaroo grass
		6Dyg	0.05 - 0.10 m grey to brown or dark loam to clay loam A1 horizon over bleached A2 horizon to 0.10 - 0.20 m over alkaline brown-mottled grey to yellow medium to heavy clay B horizon to 0.70 - 1.20 m over yellow-brown to grey fine sandy clay loam to light medium clay D horizon to 1.5+m	Solodic-solodized solonetz	Dy3.43 Dy3.33	Low open to open woodland of carbeen, cabbage gum, poplar gum, beefwood and false sandalwood with grey bloodwood and cocky apple associated with Open tussock grassland of black spear grass and purple top Rhodes grass
		6Dyh	0.15 - 0.30 m dark to brown sand to sandy loam A1 horizon over bleached A2 horizon to 0.20 - 0.50 m over alkaline yellow-mottled grey medium clay B horizon to 1.5+m	Solodic-solodized solonetz	Dy3.43 Dy3.33	Low open to open woodland of poplar gum, cabbage gum, carbeen and beefwood with grey bloodwood, false sandalwood, dead finish, chinee apple and cocky apple associated with Tussock grassland of black spear grass and love grass and blue grasses and purple top Rhodes grass

Table 4.1.1 (Continued)

Landscape unit	Landform element	Soil type	Major distinguishing attributes	Great soil group	PPF	Predominant natural vegetation
Miscellaneous alluvial landforms B. Creek and relict alluvial landforms	Levee	6Dbh	0.05 - 0.15 m grey to brown loam to clay loam A1 horizon over bleached A2 horizon to 0.10 - 0.25 m over alkaline brown light to medium clay B horizon to 0.60 - 1.00 m over brown clay loam to medium clay D horizon to 1.5+m	Solodic-solodized solonetz	Db1.43 Db1.33	Low open woodland to low woodland of beefwood, false sandalwood and carbeen with cabbage gum and grey ironbark or Tall open shrubland of beefwood occurs with Open tussock grassland of purple top Rhodes grass and blue grasses
	Floodouts, fans and levees	6Ufa	0.10 - 0.30 m brown to dark sandy clay to light clay A horizon over alkaline dark medium clay B horizon to 1.5+m	No suitable group, affinities with chernozem	Uf6.32	Low open woodland of carbeen, poplar gum and cabbage gum with beefwood and cocky apple associated with Tussock grassland of Rhodes grasses, black spear grass and blue grasses
		6Ufd	0.15 - 0.45 m dark light to light medium clay A horizon over acid to neutral dark to brown light to light medium clay B horizon to 0.70 - 1.5 m over brown to yellow sand to loamy sand D horizon to 1.5+m	Prairie soil	Uf6.32 Uf6.31	Open woodland of poplar gum, grey bloodwood and carbeen with cocky apple associated with Tussock grassland of blue grasses and black spear grass
		6Ufe	0.05 - 0.30 m brown-mottled dark to grey light to medium clay A horizon over acid to alkaline grey to brown sand D1 horizon to 0.30 - 0.70 m over neutral to alkaline sand to clay D horizons to 1.5+m	Alluvial soil	Uf6.22 Uf6.23	Open woodland to woodland of poplar gum, cabbage gum and tea-tree spp. with parkinsonia associated with Tussock grassland of blue grasses and black spear grass with brown sorghum associated
		6Dba	0.10 - 0.20 m dark to brown sandy loam to sandy clay loam A1 horizon over bleached A2 horizon to 0.15 - 0.30 m over alkaline brown medium clay B horizon to 1.5+m	Solodic-solodized solonetz	Db1.43 Db1.33	Low open to low woodland carbeen, grey bloodwood and cabbage gum with poplar gum, whitewood, beefwood and mimosa associated with Tussock grassland of black spear grass blue grasses and Rhodes grasses

Table 4 1 1 (Continued)

Landscape unit	Landform element	Soil type	Major distinguishing attributes	Great soil group	PPF	Predominant natural vegetation
Miscellaneous alluvial landforms B. Creek and relict alluvial landforms	Floodouts, fans and levees	6Dyj	0.05 - 0.20 m dark to grey sandy loam to clay loam A horizon bleached throughout or near base over grey medium to heavy clay B horizon to 1.00 - 1.50 m over grey to yellow-brown sandy loam to medium clay D horizon to 1.5+m, strongly alkaline at and below 0.30 m	Solodic-solodized solonetz	Dy2.43 Dy2.33	Low open to open woodland of poplar gum, cabbage gum and beefwood with false sandalwood, carbeen, grey bloodwood and corkwood associated with Open tussock grassland of blue grasses, giant spear grass, black spear grass and purple top Rhodes grass
		6Dd1b	0.15 - 0.30 m dark to grey coarse sand to sandy loam A1 horizon over bleached A2 horizon to 0.25 - 0.50 m over alkaline grey to dark medium to heavy clay to 1.5+m	Solodic soil	Dy2.43 Dd1.33	Low open woodland of poplar gum, carbeen, cabbage gum and beefwood with grey bloodwood and cocky apple associated with Tussock grassland of blue grasses and black spear grass
	Closed depressions	6Dda	0.10 - 0.15 m dark to brown clay loam A1 horizon over bleached A2 horizon to 0.15 - 0.25 m over alkaline dark medium clay B horizon to 0.70 - 1.10 m over grey to dark clay loam to light medium clay D horizon to 1.5+m	Solodic-solodized solonetz	Dd1.43 Dd1.33	Low open woodland to open woodland of poplar gum, carbeen, cabbage gum and beefwood with grey bloodwood associated with Tussock grassland of black spear grass, blue grasses and Rhodes grasses

5. SOILS - CHEMICAL AND PHYSICAL ATTRIBUTES

5.1 Introduction

Laboratory analyses of selected soil profiles provide quantitative measurements of important soil properties to assist in interpretation of soil and land use data.

Twenty-five soil profiles, representing 19 soil types, were sampled and analysed for this survey. Profiles were sampled to 1.5 m either from pits or from a number of 0.05 m cores. Each profile was usually sampled in 0.1 m intervals. However, when an important soil horizon boundary occurred within these intervals, the depth of sampling was adjusted accordingly to avoid sampling across horizons.

A number of other soil profiles from the survey area has previously been sampled and analysed. These include three profiles from an experimental site (Gaynor site, AMG of centroid, 529300E, 7805150N) and sites from the 1:100 000 survey of Thompson (1977). Analytical results for most of these soil profiles have been included with the data from this survey to increase the range of data used in the discussions of the attributes of the soils of the area.

Soil chemical and physical properties were analysed at intervals 0-0.1, 0.2-0.3, 0.5-0.6, 0.8-0.9 and 1.1-1.2 m or at other intervals if the 0.1 m intervals coincided with an important soil horizon boundary. Electrical conductivity, chloride percent and pH were also determined at 1.4-1.5 m. The standard suite of analyses recommended by Queensland Department of Primary Industries was undertaken according to methods described by Bruce and Rayment (1982). A bulk sample of nine 0-0.1 m samples was collected from each site for nutrient analyses.

To facilitate discussions for most of the chemical and physical attributes, soil profiles with similar morphology and within the same landscape unit were grouped. However, some sampled profiles could not be suitably placed in a group and were left as individual profiles. For a discussion of some attributes it was more relevant to use broader groups. These broader groups are given in the appropriate sections.

The site number and survey for each analysed profile are presented in Table 5.1.1. This table also provides a brief description of the soil groups or individual soil types.

The analytical results for a particular attribute and depth, either from a single profile or averaged for a group, or from a number of profiles of the same soil type, were compared within the same landscape unit. Some comparisons of the soil types or groups with similar morphological properties were made between landscape units.

A summary of ratings for some important laboratory attributes for the soil types or groupings is given in Table 5.1.2.

Detailed morphological and analytical data for the analysed soil profiles for this survey and for the Gaynor site are presented in Appendix III.

Table 5.1.1 A brief description of the soil types or soil groups with the survey and site number of each sampled soil profile.

Soil types or groups*	Survey+	Site no.	Brief description
1Uga (m)**	CWRB	S08	Cracking clays of landscape unit 1 with A
1Ugd (m)	NLH	S20A	horizon texture of light medium to medium
1Ugd (d)**	NLH	S20B	clay.
1Ugf (m)	CWRB	S05	Cracking clays of landscape unit 1
	NLH	S13	with A horizon texture of
	GAY	SGN3	light clay.
1Ugf (d)	NLH	S14	
1Dyc	CWRB	S10	Solodic-solodized solonetz of landscape
	GAY	SGN1	unit 1 with grey B horizons.
	GAY	SGN2	
1Dda	CWRB	S07	Solodic-solodized solonetz oflandscape unit 1 with dark B horizons.
2Uga (m)	NLH	S23A	Cracking clays of landscape unit 2 with A
2Ugh (m)	CWRB	S01	horizons of medium clay.
2Uga (d)	NLH	S23B	
2Ugd (m)	CWRB	S03	Cracking clays of landscape unit 2 with A
2Ugc (m)	BRB	15A	horizons of light to light medium clay.
2Ugc (d)	BRB	15B	
2Dba	BRB	17	Solodic-solodized solonetz of landscape unit 2 with A horizon < 0.12 m and pH > 8.5 at 0.3 m.
2Dbb	BRB	18	Solodic-solodized solonetz of landscape
2Dyb	CWRB	S02	unit 2 with A horizon < 0.12 m and pH
2Dya	CWRB	S09	< 8.5 at 0.3 m (2Dya) or with A horizons between 0.12 and 0.2 m.
3Uga	BRB	19	Black earth of landscape unit 3.
3Ugd	BRB	22	
3Uga8	CWRB	S11	Black earth of landscape unit 3 with significant amounts of small pebbles throughout the B horizon.
5Dra	NLH	S19	Non-calcic brown soil of landscape unit 5.
	NLH	S22	
	BRB	35	

Table 5.1.1 (Continued)

Soil types or groups*	Survey+	Site no.	Brief description
5Dya	BRB	36	Yellow equivalent of non-calcic brown soil of landscape unit 5.
5Dyb	BRB	37	Yellow duplex soil with alkaline soil reaction trend of landscape unit 5.
5Uga	NLH	S12	Black earth or cracking clay of landscape unit 5.
5Uga	NLH	S21	
5Uga	BRB	39	
5Ugb	NLH	S15	
5Ugc	NLH	S17	Cracking clay from depression of soil complex with linear gilgai of landscape unit 5.
5Dyc	CWRB	S06	Solodic-solodized solonetz of landscape unit 5.
5Dyc	BRB	38	
5Dyf	NLH	S18	
6Dbb	NLH	S16	Solodic soil of landscape unit 6 with A horizon > 0.3 m.
6Dbh	CWRB	S04	Solodic-solodized solonetz of landscape unit 6 with A horizon < 0.25 m.

* **Soil groups in bold.**

** (m) mound
(d) depression

\+ CWRB Clare Weir Right Bank (Southern Leichhardt Downs Section)
NLH Northern Leichhardt Downs Section
GAY Gaynor site
BRB Burdekin Right Bank (Thompson 1977).

Table 5.1.2 Ratings* for salinity, sodicity and nutrients for the soil types or soil groups

Soil type or *group*	Soil salinity	Sodicity		Extractable phosphorus		Extractable potassium	Manganese	Copper	Zinc	Total nitrogen	Organic carbon	Total sulphur
		0.2-0.3*m*	0.8-0.9*m*	Acid	Bicarbonate							
1Uga,d	v. low**	non sodic	sodic	v. low	v. low	medium	medium	medium	medium	low	low	low
1Ugf	medium	sodic	s. sodic***	v. low	v. low	medium	high	medium	low	medium	low	low
1Dyc	high	s. sodic	s. sodic	v. low	v. low	low	medium	medium	v. low	low	low	low
1Dda	low	s. sodic	s. sodic	v. low	v. low	medium	high	medium	low	low	low	low
2Uga, h	v. low	non sodic	sodic	v. low	low	high	medium	medium	low	low	low	low
2Ugc, d	v. low	non sodic	sodic	medium	low	high	medium	medium	low	low	low	medium
2Dba	medium	s. sodic	s. sodic	low	medium	medium				low	low	low
2Dya, b, 2Dbb	medium	sodic	s. sodic	v. low	low	high	medium	medium	low	medium	low	low
3Uga, d	v. low	non sodic	sodic	low	v. low	high				low	low	low
3Uga8	v. low	non sodic	sodic	low	v. low	high	medium	medium	low	low	low	low
5Dra	v. low	non sodic	non sodic	low	low	medium	high	medium	low	low	low	low
5Dya	v. low	non sodic	non sodic	medium	low	medium				low	low	low
5Dyb	v. low	non sodic	sodic	medium	low	medium				low	low	low
5Uga, b	v. low	non sodic	non sodic	medium	low	medium	medium	medium	low	low	low	medium
5Ugc	medium	sodic	s. sodic	v. low	v. low	low	high	medium	low	low	low	low
5Dyc, f	high	s. sodic	s. sodic	low	v. low	low	high	medium	v. low	low	low	low
6Dbb	v. low	non sodic	sodic	high	medium	high	high	medium	medium	low	medium	low
6Dbh	medium	s. sodic	s. sodic	low	low	high	medium	medium	low	low	low	low

* Soil salinity rating as weighted average root-zone salinity to 0.9 m from predicted ECse values after Shaw *et al.* (1986). Sodicity ratings after Northcote and Skene (1972). Other ratings for the 0-0.1m depth after Bruce and Rayment (1982).

** Very low

*** Strongly sodic

5.2 Soil pH

Soil pH is an easily determined measurement of the intensity of soil acidity or soil alkalinity. Soil pH reflects the base status of the soil and the availability of nutrients and the presence or absence of toxic elements can be inferred from it.

To increase the number of values and enable a statistical analyses to be performed on the data, the soils were divided into three broad groups. These groups were cracking clays, solodic-solodized solonetz and other duplex soils. Table 5.2.1 presents mean values of soil pH with standard deviations for these groups of soils and also for all the soils analysed.

The mean pH of the surface soil (0-0.1 m) for all soils is slightly acid (pH 6.1-6.5). The cracking clays become moderately alkaline (pH 7.9-8.4) at 0.5-0.6 m and strongly alkaline (pH 8.5-9.0) at 0.8-0.9 m. The solodic-solodized solonetz become very strongly alkaline (pH > 9.0) by 0.5-0.6 m. The other duplex soils are neutral(pH 6.6-7.3) at depth except for 5Dyb which is strongly alkaline in the BC or C horizon. This profile tends to increase the mean pH of the group at depth.

Table 5.2.1 Mean pH and standard deviations for soil groups of cracking clays, solodic-solodized solonetz and other duplex soils for five soil depths.

Soil group	Mean pH and standard deviations Depth (m)				
	0-0.1	0.2-0.3	0.5-0.6	0.8-0.9	1.1-1.2
Cracking clays	6.4±0.4	7.4±0.7	8.2±0.7	8.8±0.3	8.9±0.3
Solodic-solodized solonetz	6.3±0.4	8.2±0.9	9.1±0.5	9.1±0.4	9.0±0.5
Other duplex soils	6.5±0.2	6.3±0.3	6.9±0.5	7.3±0.7	7.5±1.0
All soils	6.4±0.3	7.5±1.0	8.4±0.9	8.7±0.7	8.8±0.7

5.3 Salinity

The level of total soluble salts is an important attribute as excessive quantities affect crop growth by (i) reducing water availability through osmotic pressure effects and (ii) by toxicity effects on plant metabolism.

Total soluble salt content was determined by electrical conductivity on 1:5 soil water mixtures (EC1:5). Shaw *et al*. (1986) stated that while EC1:5 is a convenient laboratory measurement,

saturation extract (ECse) is a more useful determination to relate to plant reponse. The EC1:5 values were therefore converted to ECse using a model developed by Shaw et al. (1986).

5.3.1 Comparisons within landscape units.

ECse profiles for the soil types or soil groups of LUs 1, 2, 3, 5 and 6 of Table 5.1.1 are shown in Figures 5.3.1 to 5.3.5.

All soils of LU 1 become moderately saline at depth (United States Salinity Laboratory 1954). Soil type 1Dyc has the highest concentration of salts of LU 1 and becomes very saline (ECse > 9.0 dS m^{-1}) at 0.5-0.6 m. McCown et al. (1976) and Mullins (1981) suggest that a concentration of salts in the profile indicate the depth to which wetting under rainfall occurs. The salinity profile for soil type 1Dyc peaks at 0.5-0.6 m which suggests that 1Dyc has a low plant available water capacity. This has been shown by Gardner and Coughlan (1982) and Elliot (personal communication).

In LU 1, the cracking clay with A horizon texture of light clay (1Ugf) has a higher salt concentration than the soil types with the heavier textured A horizons (1Uga, 1Ugd) and intermediate between the two solodic-solodized solonetz (1Dyc and 1Dda). Shaw et al. (1986) found that clay content, CCR (CEC/clay ratio), exchangeable sodium percentage (ESP) and rainfall were important factors affecting soil leaching and therefore salinity. These soil types have similar clay content in the B horizons and CCRs but 1Ugf has higher ESP levels (> 10 percent) in the profile and this may have some affect on the salinity levels. Field observations reveal that the density and size of surface cracks are greater on 1Uga and 1Ugd than 1Ugf. The cracking pattern in the heavier textured group suggests a better leaching environment because of ease of water entry and therefore reduced salinity levels.

All soils of LU 2 become slightly to moderately saline at depth. The solodic-solodized solonetz groups (2Dbb, 2Dyb and 2Dya, and 2Dba) have higher salt concentrations than the clays. The salt content of the cracking clays with light to light medium clay A horizons (2Ugd, 2Ugc) is slightly lower than the other cracking clay group with medium clay A horizons.

A variant of 3Uga which has significant amounts of small pebbles throughout the profile (3Uga8) has slightly higher salinity levels than 3Uga and 3Ugd. Smith et al. (1978) and Shaw et al. (1986) showed that soils with lowest porosity and hence leaching have about 50% clay. Soil type 3Uga8 has about 50 percent clay, in contrast to 3Uga and 3Ugd with 80 percent clay, and this may account for the slightly higher salt content due to the poorer soil drainage characteristics.

Soil types of LU 5 have extremely contrasting salinity profiles. Solodic-solodized solonetz (5Dyc, 5Dyf) are very saline below 0.5-0.6 m with a maximum concentration of > 12 dS m^{-1} at 0.8-0.9 m. Soil types 5Dra, 5Dya and 5Dyb are non-saline as these soils are permeable and well drained. Cracking clays 5Uga and 5Ugb become slightly saline at depth while 5Ugc, intimately associated with 5Dyf, becomes very saline.

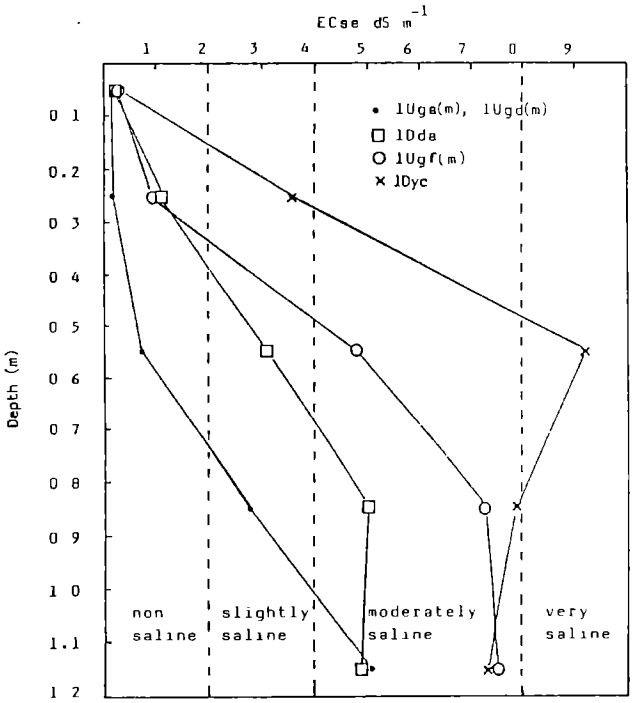


Figure 5.3.1 ECse profiles (Landscape unit 1).

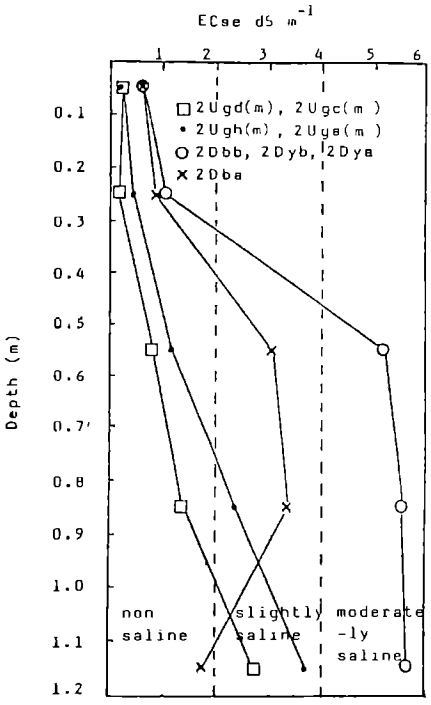


Figure 5.3.2 ECse profiles (Landscape unit 2).

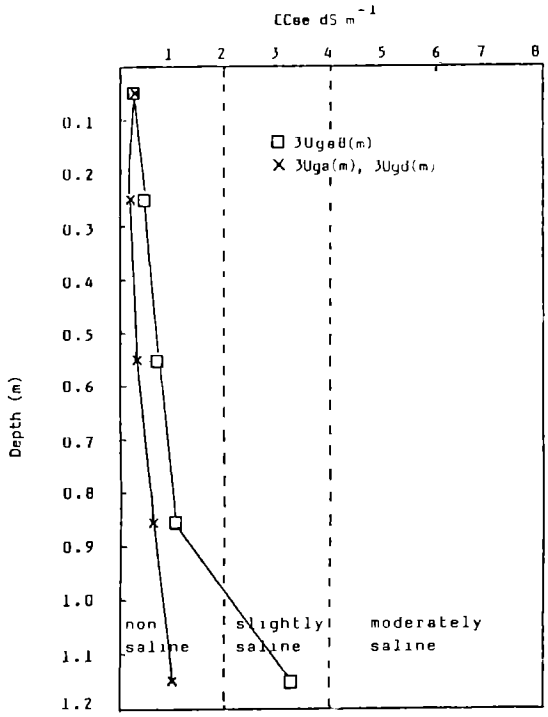


Figure 5.3.3 ECse profiles (Landscape unit 3).

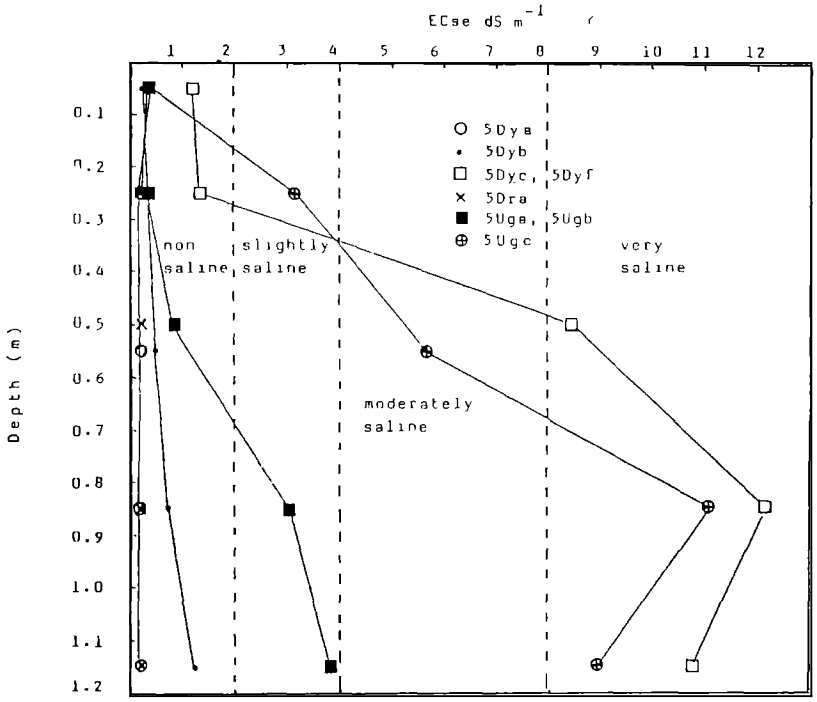


Figure 5.3.4 ECse profiles (Landscape unit 5).

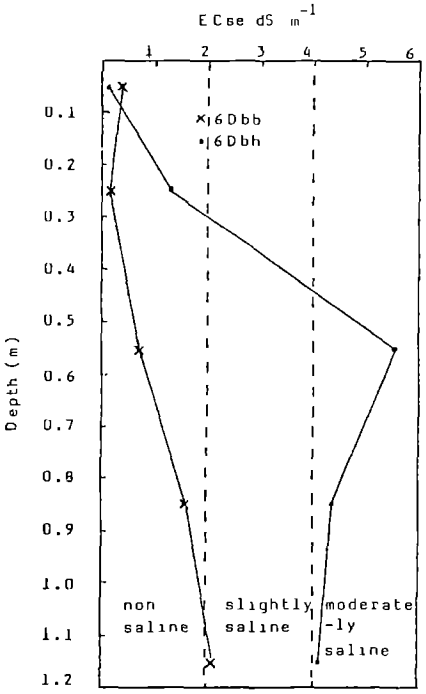


Figure 5.3.5 ECse profiles (Landscape unit 6).

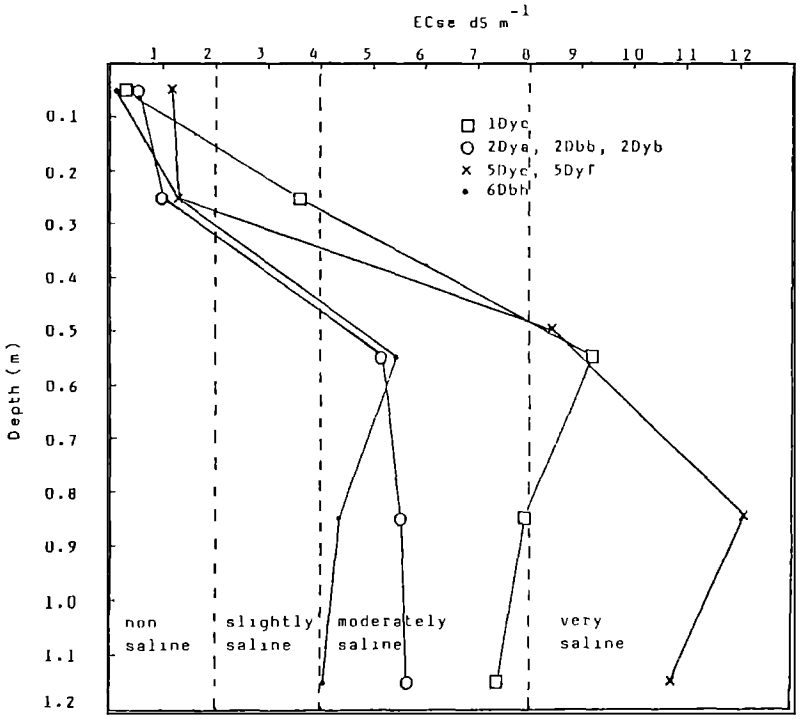


Figure 5.3.6 ECse profiles of some solodic-solodized solonetz of four landscape units.

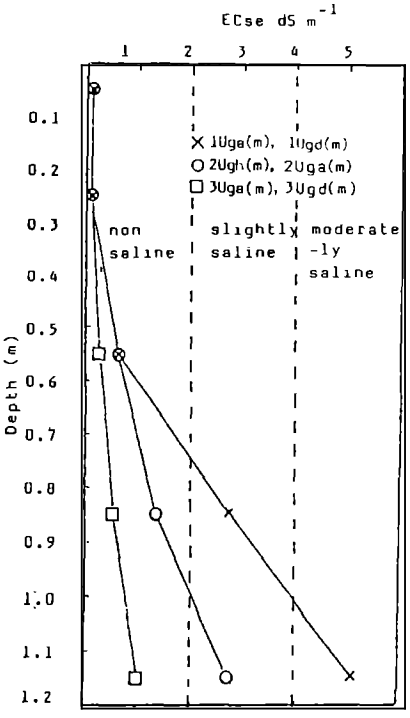


Figure 5.3.7 ECse profiles of some cracking clays of three landscape units.

Of the two profiles sampled in LU 6, soil type 6Dbh becomes moderately saline below 0.5-0.6 m while 6Dbb is non-saline.

5.3.2 Comparisons between landscape units.

Figures 5.3.6 and 5.3.7 show the relationship between selected soil groups with similar profile morphology but on different landscape units.

Figure 5.3.6 shows that the solodic-solodized solonetz of LU 5 are very saline with 6Dbh (on LU 6) having the lowest concentration. Intermediate between these are the moderately saline solodic-solodized solonetz of LU1 and 2. The peak usually occurs at 0.5-0.6 m although the groups containing soil types 5Dyc and 5Dyf has maximum concentration at 0.8-0.9 m, this depth usually being the BC horizon.

Figure 5.3.7 shows that the salt content of the cracking clays is much lower than that of the solodic-solodized solonetz. The salt profile increases from 0.5-0.6 m with the heavier textured cracking clay of landscape unit 1 increasing to moderately saline by 1.2 m. No salt bulges occur in any of the cracking clay groups.

5.3.3 Chloride

The choride percentage of the total soluble salts (TSS) can be estimated by using the formulae (Cl% x 6.4) /(EC1:5) x 100) (Shaw et al. 1986). No conclusion could be drawn about the percent chloride by combining the soils into small groups as the range of values was large, even between soils of similar morphology. However, some trends were evident by using the values from a greater number of soil types of similar morphology combined into broader groups. The broader groups were - cracking clays, solodic solodized solonetz and other duplex soils of all landscape units. The percent chloride of the total soluble salts and standard deviation for these three soil groups for five soil depths is shown in Table 5.3.1

The standard deviations in Table 5.3.1 show that the percent chloride values vary considerably within the groups. The chloride percentages in the solodic-solodized solonetz range from about 70 to 80 percent in the B horizons. The cracking clays have lower percentages of between 40 percent and 55 percent although this increases to about 70 percent at 1.1-1.2 m. This indicates that within the cracking clays other salts are contributing a greater proportion of the TSS than in the solodic-solodized solonetz. Also, as chloride is a more mobile ion, the concentration at depth is probably due to the better leaching environment in the cracked state of the upper B horizons of the cracking clays.

The other group, other duplex soils, have low salt content and chloride contributes 40 to 60 percent.

Table 5.3.1 Percentage chloride contribution to the total soluble salt concentration and standard deviations for three broad soil groups for five soil depths.

Soil group	Depth (m)				
	.0-0.1	0.2-0.3	0.5-0.6	0.8-0.9	1.1-1.2
Cracking clays	49±22	43±22	52±26	55±25	69±23
Solodic-solodized solonetz	60±21	68±26	80±12	78±20	74±21
Other duplex soils	55±20	58±14	43±20	42±21	44±24

5.4 Cation exchange capacity (CEC)and exchangeable cations.

5.4.1 Cation exchange capacity (CEC).

Measurements of CEC can be used to indicate the potential fertility of a soil. CEC is essentially a property of the clay and organic matter fractions.

Figures 5.4.1 to 5.4.6 illustrate profile trends for cation exchange capacity (CEC) and cations, sodium (Na), magnesium (Mg) and calcium (Ca) for the soil types or soil groups listed in Table 5.1.1.

Using the ratings for CEC from Landon (1984), the A horizons of the duplex soils in this survey would be rated as low (5-15 m. eq. 100 g^{-1}). The A horizon of the cracking clays range from medium (15-25 m. eq. 100 g^{-1}) to very high (> 40 m. eq. 100 g^{-1}) .

5.4.2 Exchangeable cations

Calcium dominates the exchange complex of soil types or soil groups 3Uga and d, 5Dra, 5Uga and 5Ugb, and 6Dbb as well as the upper profile (< 0.5-0.6 m) of 2Uga and 2Ugd. Calcium and magnesium levels are similar in the upper profile (< 0.5-0.6 m) in the other soil types of LUs 1 and 2 but magnesium dominates below this depth. The one exception is 2Dba where sodium is dominant throughout. Sodium is also the most common cation in 5Dyc and 5Dyf, and 6Dbh at depth.

In most soils, exchangable calcium is regarded as the most important of all cations, as in addition to being a plant nutrient, it promotes flocculation and inhibits dipersion of the soil. The levels of calcium required in a soil for optimum soil conditions and plant growth are difficult to access as the requirements vary with a number of factors including pH of the soil and the levels of other cations on the exchange complex (Landon 1984). However, soils with less calcium than 5 m. eq. 100 g^{-1} of soil should be regarded as deficient. Using this

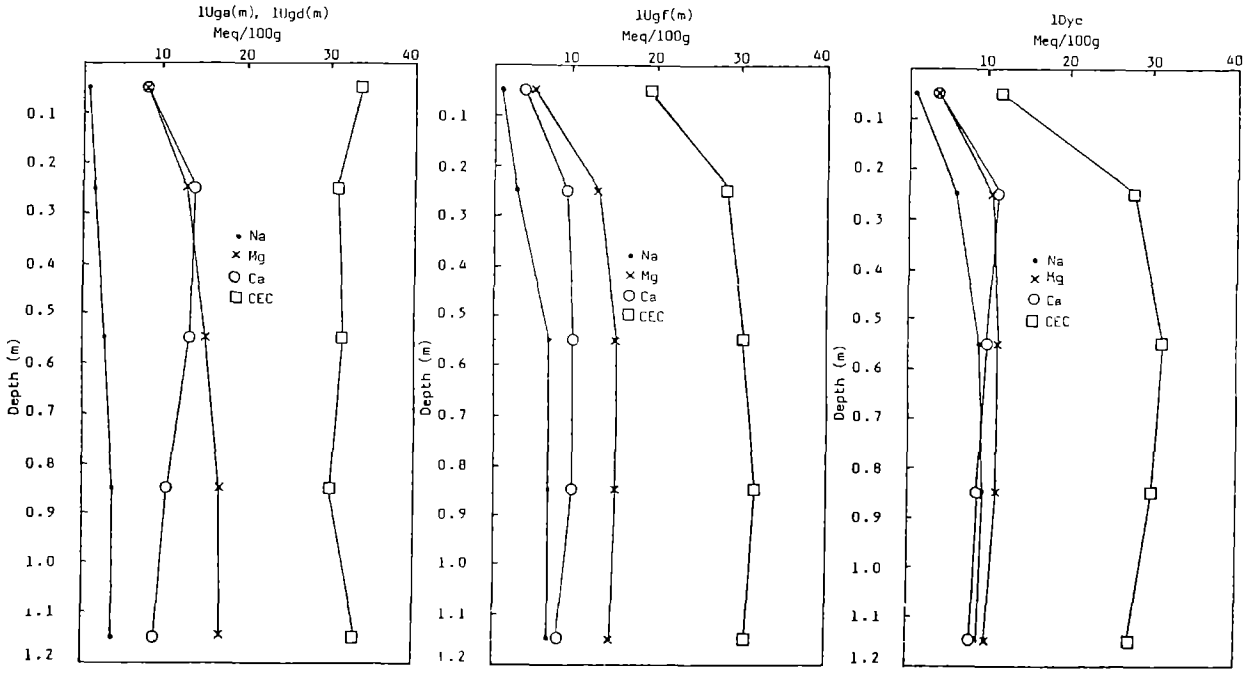


Figure 5.4.1 Exchangeable sodium, magnesium, calcium and cation exchange capacity (CEC) for soil types or groups of landscape unit 1.

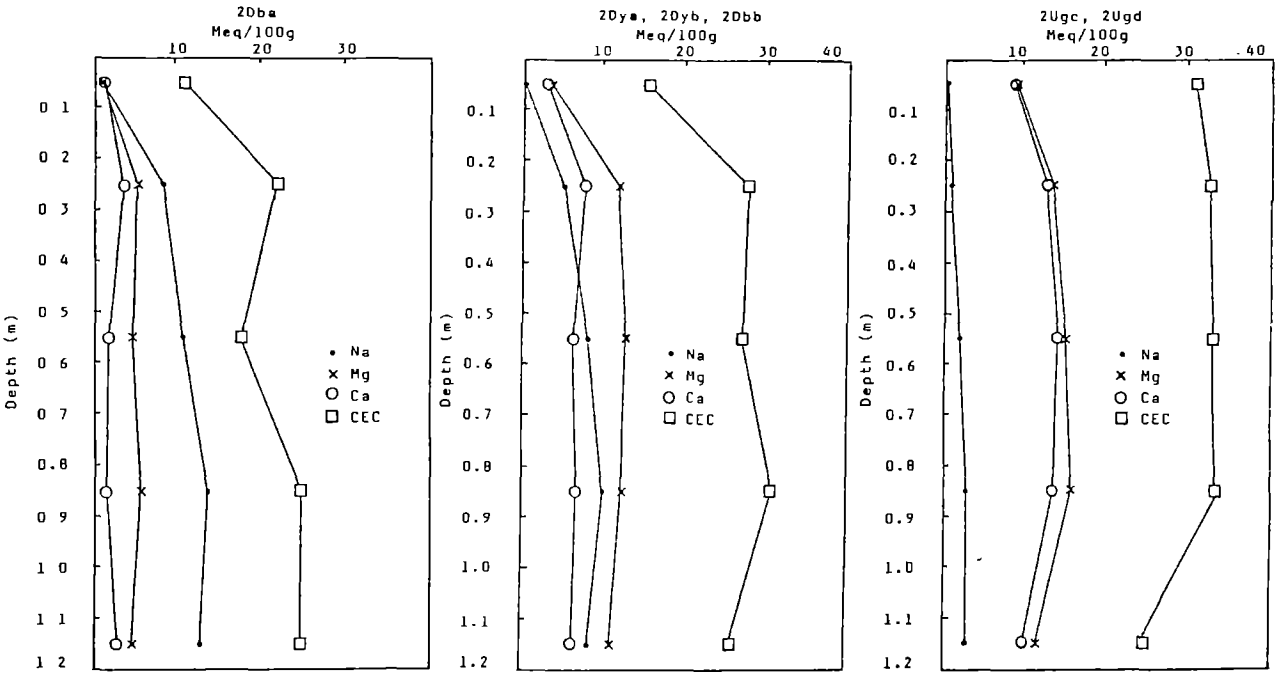


Figure 5.4.2 Exchangeable sodium, magnesium, calcium and cation exchange capacity (CEC) for some soil types or groups of landscape unit 2.

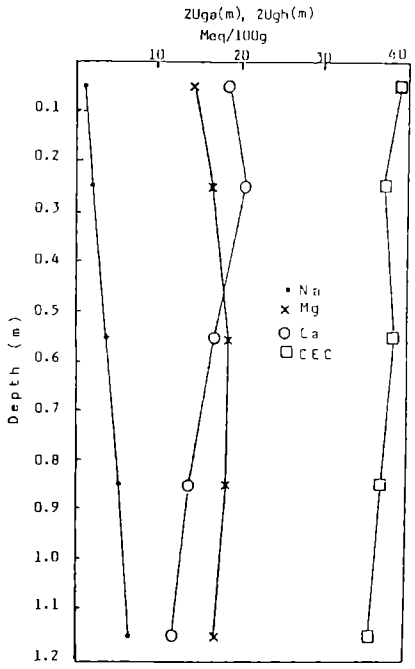


Figure 5.4.3 Exchangeable sodium, magnesium, calcium and cation exchange capacity (CEC) for soil group 2Uga(m) and 2Ugh(m).

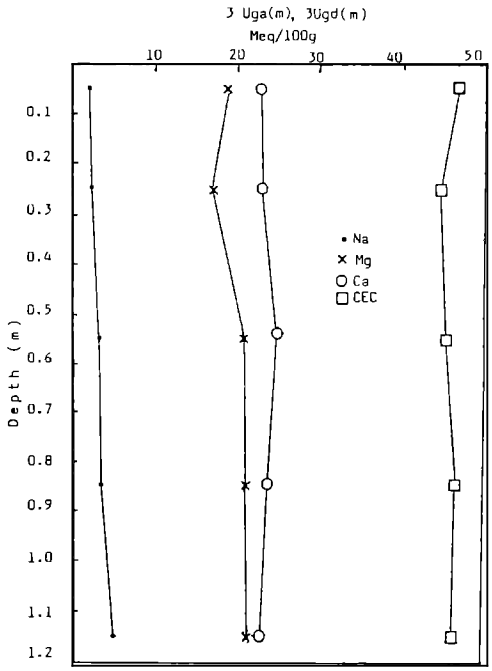


Figure 5.4.4 Exchangeable sodium, magnesium, calcium and cation exchange capacity (CEC) for soil group 3Uga(m) and 3Ugd(m).

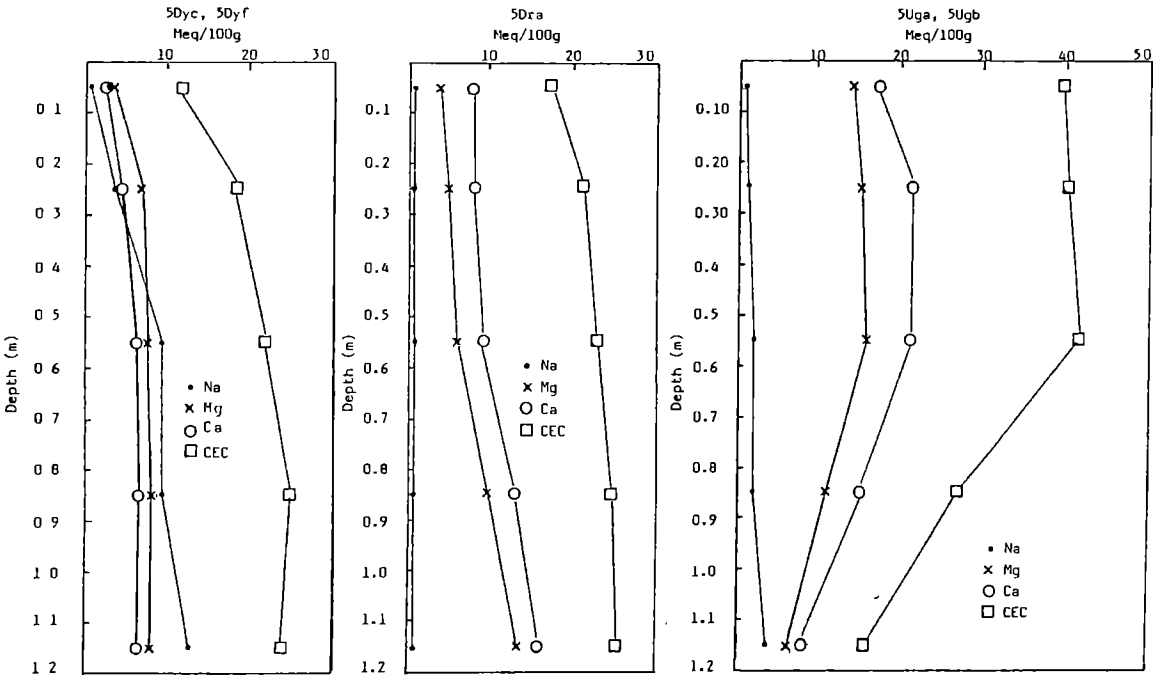


Figure 5.4.5 Exchangeable sodium, magnesium, calcium and cation exchange capacity (CEC) for soil types or groups of landscape unit 5.

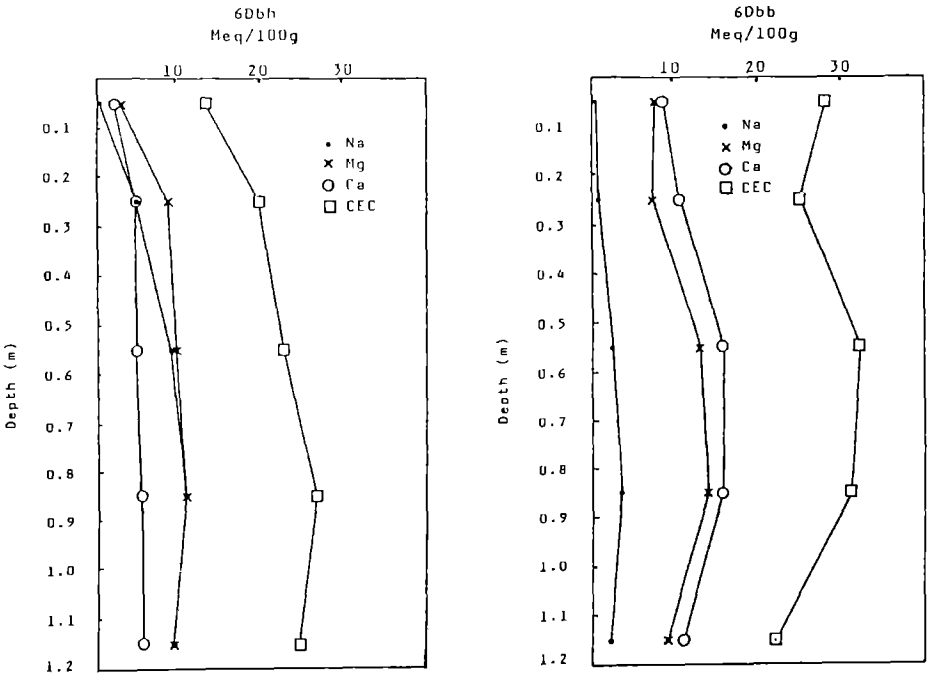


Figure 5.4.6 Exchangeable sodium, magnesium, calcium and cation exchange capacity (CEC) for soil types of landscape unit 6.

criteria, soil type 2Dba and soil groups 5Dyc and 5Dyf, and 2Dbb, 2Dya and 2Dyb could be classed in this category.

The effects of exchangeable magnesium on the exchange complex is often considered equivalent to the effects of calcium due to its divalent nature, but some workers, including Darab (1980), have shown that it may adversely affect soil conditions. Kelley (1964) stated that the effects of exchangeable sodium is dependant on the nature of the other cations on the exchange complex. McNeal et al. (1968) and Bakker and Emerson (1973) have shown that sodium-magnesium soils have more clay dispersion and swelling and lower hydraulic conductivity than sodium-calcium soils. It is not clear when the level of magnesium is harmful but Rengasamy et al. (1984) suggest that when sufficient sodium is present (SAR* > 3), a 15 percent reduction in hydraulic conductivity of red-brown earths could occur if the exchangeable Ca/Mg ratio is less than unity compared to a higher Ca/Mg ratio.

All the solodic-solodized solonetz, except 6Dbb and 1Dda, have Ca/Mg ratios less than 1 especially below depths of 0.5-0.6 m. Soil type 1Dda has a comparatively high ratio of > 1.2 for all depths. Most cracking clays except 3Uga and 3Ugd, also have ratios < 1 at depth. Soil type 1Ugf has the lowest values between 0.6 and 0.8 at all depths. These ratios, especially those of the solodic-solodized solonetz combined with their high ESP ratios, suggest that clay dispersion would be high and hydraulic conductivity very low. Loveday (1976) has shown that when the Ca/Mg ratio is low most of the applied calcium in the form of gypsum is adsorbed due to exchange with magnesium. The amelioration affect of gypsum when applied at an economic level to those soils with a high ESP as well as a low Ca/Mg ratio may therefore be relatively ineffective in reducing sodium to an acceptable level.

Mean exchangable potassium levels of selected soil types or groups for three depths are shown in Table 5.4.1. The values for the surface layer (0-0.1 m), except for 1Dyc and 5Dyc and 5Dyf, are above the critical level of 0.2 m. eq. 100^{-1}g suggested by Williams and Lipsett (1960) and Piper and DeVries (1960) as associated with deficiences. The values for 1Dyc and 5Dyc and 5Dyf suggest that these soils will require potassium fertiliser.

At depth, low values (< .21 m. eq. 100^{-1}g) are associated with the soils of LUs 1 and 5 (except 1Dyc at 1.1-1.2 m). Higher values occur in the soils of LUs 2,3, and 6.

(* SAR Sodium adsorption ratio)

Table 5.4.1 Mean exchangeable potassium (K) (m. eq. $100g^{-1}$) for selected soil types or groups for three soil depths.

Soil types or groups	Depth(m)		
	0-0.1	0.5-0.6	1.1-1.2
1Ugf(m)	0.36	0.17	0.21
1Dyc	0.17	0.2	0.35
2Uga(m) 2Ugh(m)	0.56	0.38	0.39
2Dbb, 2Dya 2Dyb	0.63	0.26	0.32
3Uga(m) 3Ugd(m)	0.75	0.45	0.4
5Dra	0.35	0.15	0.12
5Uga, 5Ugb	0.26	0.17	0.19
5Dyc, 5Dyf	0.12	0.14	0.13
6Dbh	0.53	0.29	0.29
6Dbb	0.87	0.33	0.38

5.5 Sodicity and dispersion.

High levels of sodium can affect plant growth by direct toxicity, by development of poor soil physical conditions and by reducing the availability of and causing imbalances between calcium and magnesium.

Northcote and Skene (1972) developed three sodicity classes based on exchangeable sodium percentage (ESP): non sodic (ESP < 6), sodic (ESP6-14), and strongly sodic (> 15). These sodicity classes are usually used to rate soils.

5.5.1 Comparisons within landscape units.

Figures 5.5.1 to 5.5.5 show the ESP profiles for the soil types or soil groups as listed in Table 5.1.1.

All soil types of LU 1 are strongly sodic by 1.2 m. Soil types 1Dyc and 1Dda are strongly sodic by 0.3 m while 1Ugf does not become strongly sodic until 0.6 m.

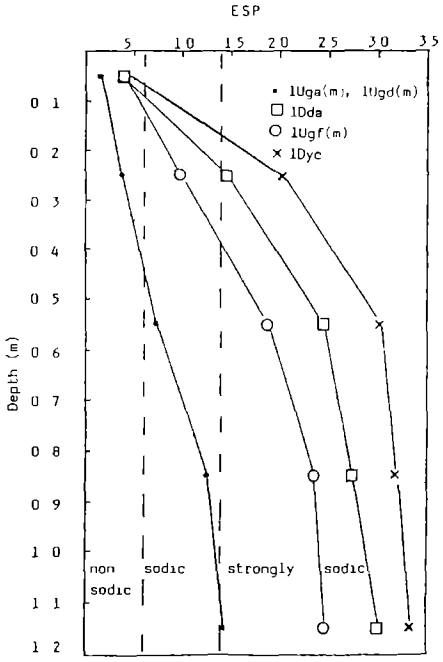


Figure 5.5.1 ESP profiles (Landscape unit 1).

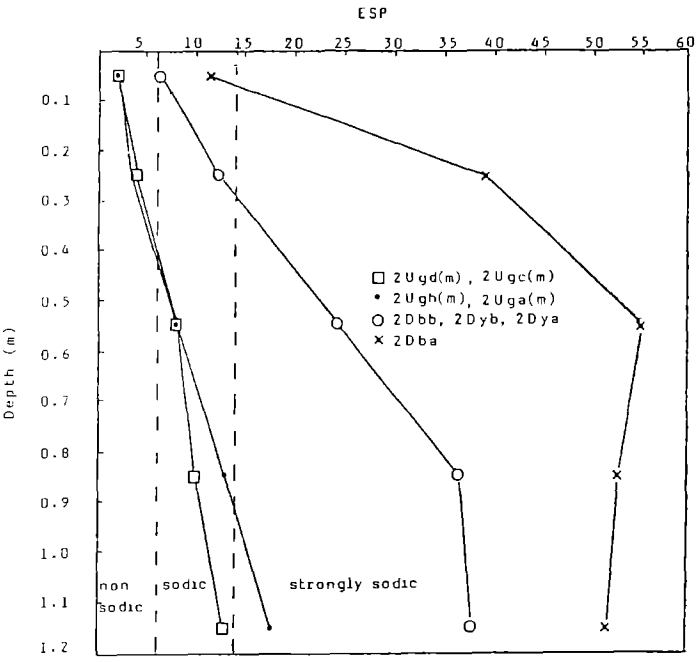


Figure 5.5.2 ESP profiles (Landscape unit 2).

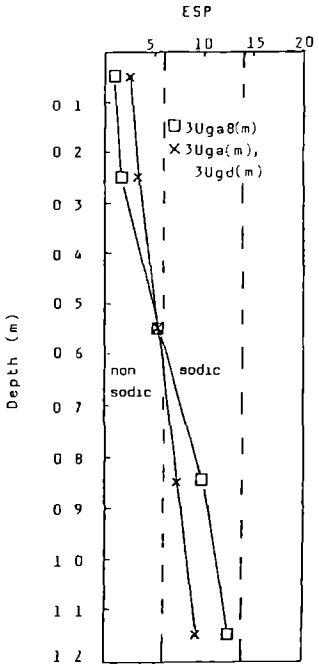


Figure 5.5.3 ESP profiles (Landscape unit 3)

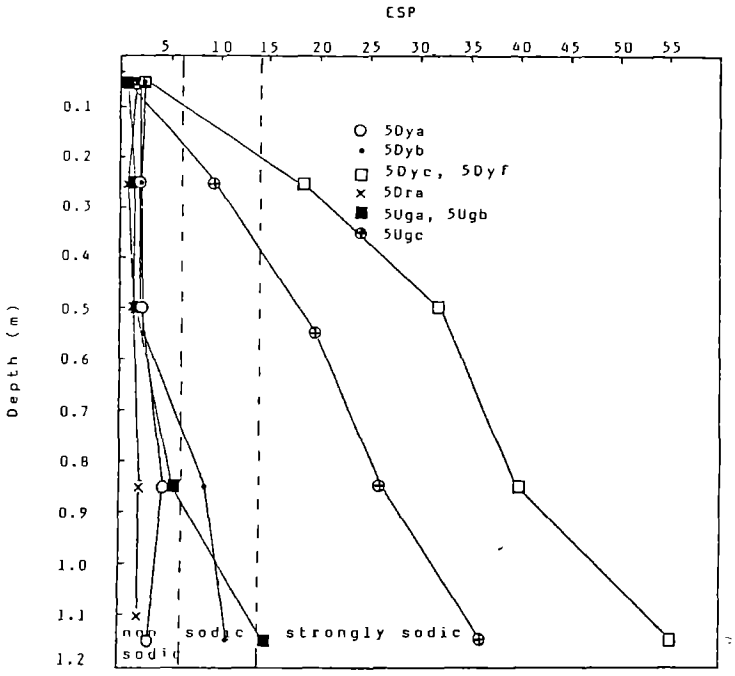


Figure 5.5.4 ESP profiles (Landscape unit 5).

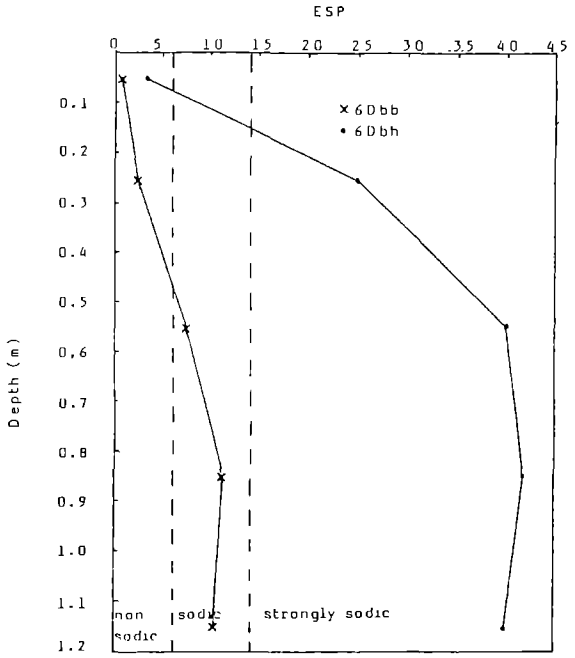


Figure 5.5.5 ESP profiles (Landscape unit 6).

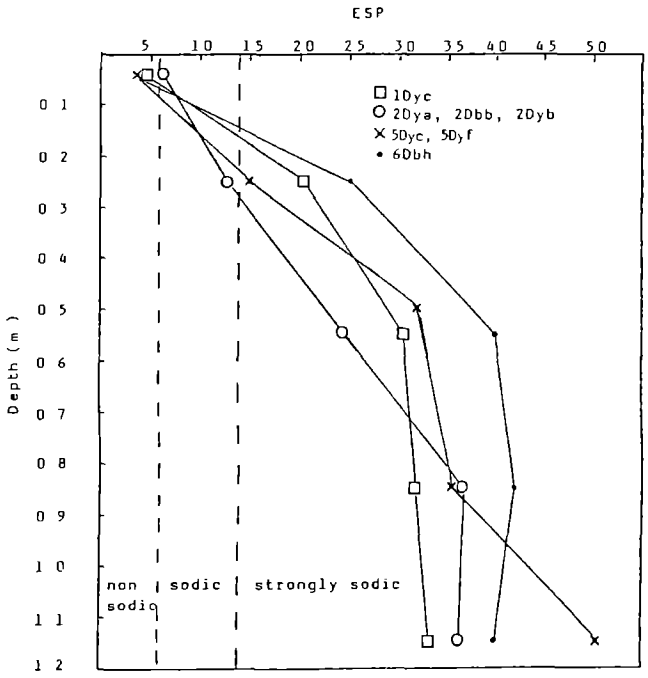


Figure 5.5.6 ESP profiles of solodic-solodized solonetz of landscape unit 1, 2, 5 and 6.

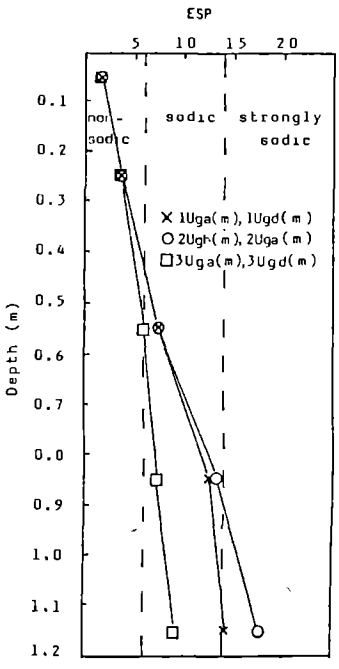


Figure 5.5.7 ESP profiles of the cracking clays of landscape unit 1, 2 and 3.

The solodic-solodized solonetz (soil type 2Dba, and soil group 2Dbb, 2Dya, 2Dyb) have the highest ESPs of LU 2. Soil type 2Dba has an ESP of about 40 at 0.3 m and 50 to 60 below this. The soil group of 2Dbb, 2Dya and 2Dyb are not strongly sodic until 0.5-0.6 m but still reach ESP levels between 35 to 40 at depth. The cracking clays reach ESP values between 13 and 17 at 1.2 m.

The cracking clays of LU 3 become sodic at depth. Soil types 5Dyc and 5Dyf are strongly sodic by 0.2-0.3 m and the ESP values increase down the profile. The ESP profile of 5Ugc has a similar trend but the ESP levels are lower.

Soil type 6Dbh is strongly sodic by 0.2-0.3 m increasing to an ESP of about 40 from 0.6 to 1.2 m. Soil type 6Dbb only becomes sodic at depth.

5.5.2 Comparisons between landscape units.

ESP profiles for solodic-solodized solonetz for LUs 1, 2, 5 and 6 and cracking clay groups for LUs 1, 2 and 3 are shown in Figure 5.5.6 and 5.5.7 respectively. All the solodic-solodized solonetz groups are strongly sodic by 0.5-0.6 m but only the cracking clays of LU 1 and LU 2 become strongly sodic by 1.1-1.2 m.

Those soils with strongly sodic B horizons especially those with high levels between 0.2 and 0.6 m will present problems with clay dispersion, resulting in low hydraulic conductivity and low plant available water capacity (PAWC).

5.5.3 Dispersion

The tendency for soils to disperse in water has been quantified in terms of a dispersion ratio index R1. High dispersion ratios suggest low permeability. The surface layers of the cracking clays of all landscape units have a low tendency to disperse (R1 < 0.6, Reid and Baker 1984) (except 5Ugc and 3Uga which have a moderate tendency). The solodic-solodized solonetz have moderate (R1 0.6 to 0.8) to high (R1 > 0.8) tendency to disperse. The values of other duplex soils such as 5Dra, 5Dya and 5Dyb vary from .58 to .79.

At depth, most soil types or soil groups have a high tendency to disperse with the exceptions of 3Uga and 3Ugd, 5Dra, 5Dya, 5Dyb and 5Uga and 5Ugb. The values for solodic-solodized solonetz are usually higher (> 0.9) at shallower depths and greater than those of the cracking clays (exception 1Ugf).

5.6 Clay content, clay activity ratio and clay mineralogy.

Figures 5.6.1 to 5.6.5 indicate clay percentages for the soil types or groups listed in Table 5.1.1.

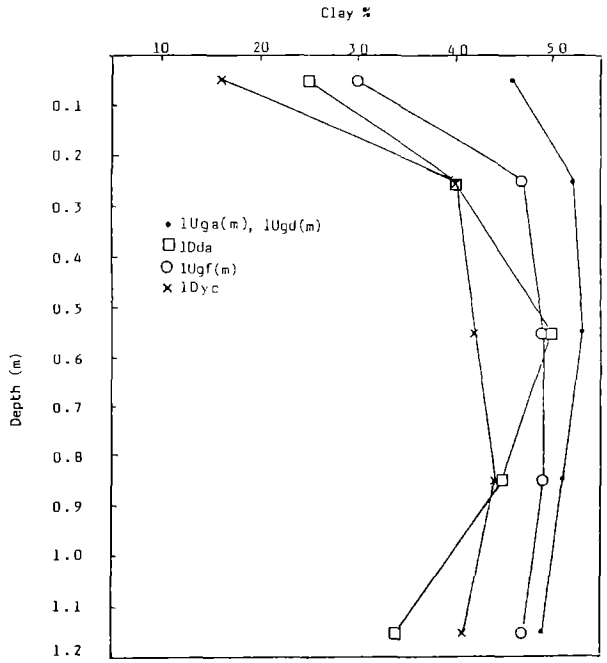


Figure 5.6.1 Clay percentage profiles for soil types or groups of landscape unit 1.

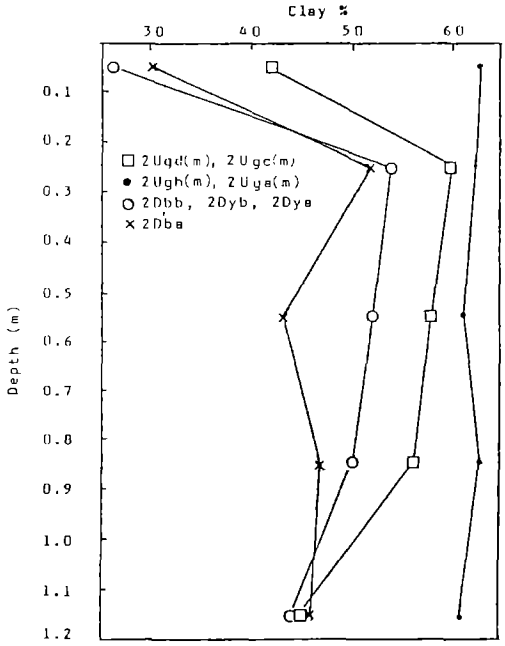


Figure 5.6.2 Clay percentage profiles for soil types or groups of landscape unit 2.

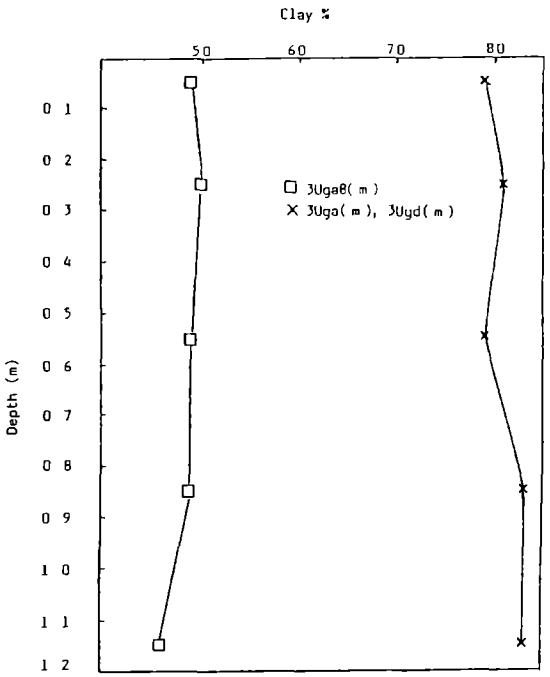


Figure 5.6.3 Clay percentage profiles for soil types or groups of landscape unit 3.

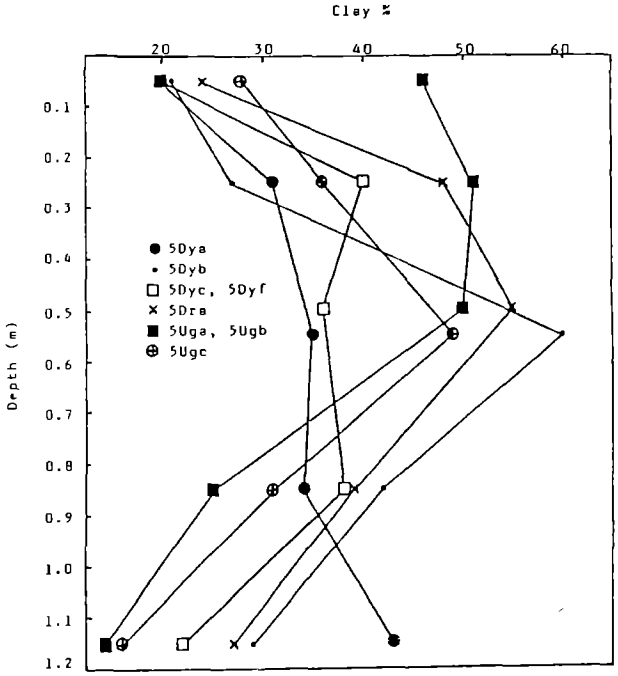


Figure 5.6.4 Clay percentage profiles for soil types or groups of landscape unit 5.

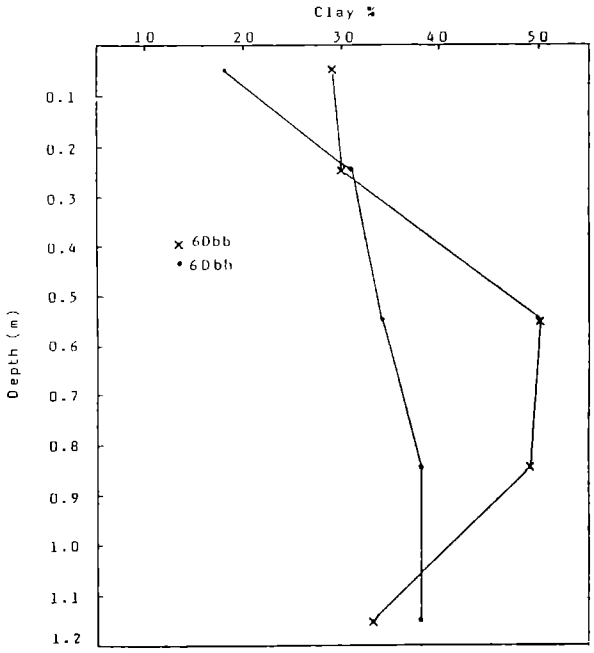


Figure 5.6.5 Clay percentage profiles for soil types of landscape unit 6.

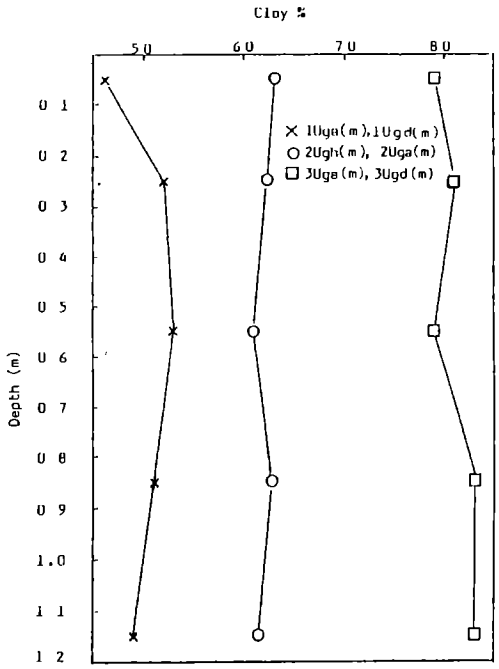


Figure 5.6.6 Clay percentage profiles for some cracking clay soil groups of landscape unit 1, 2 and 3.

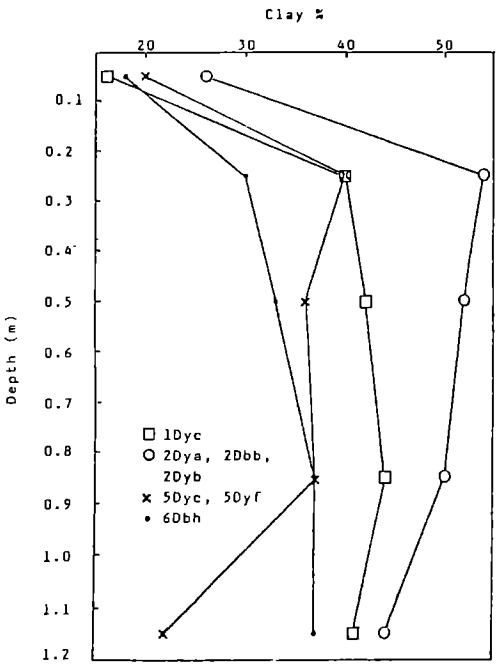


Figure 5.6.7 Clay percentage profiles for some solodic-solodized solonetz groups of landscape unit 1, 2, 5 and 6.

5.6.1 Comparisons of clay content within landscape units

The A and B horizons of the soil types or soil groups of LU 1 can be ranked in order of decreasing clay content. This order is 1Uga and 1Ugd > 1Ugf > 1Dda > 1Dyc. Clay percentages usually decrease at depth especially for 1Dda, where lighter textured D horizons are present.

The soil group of 2Ugd and 2Ugc has A and B horizons of slightly lower clay content than soil group, 2Uga and 2Ugh. The soil group of 2Dbb, 2Dyb and 2Dya has higher clay percentages in the B horizon than 2Dba. The decrease in clay content at depth (< 0.9 m) is again due to the presence of D horizons.

The difference of 30 percent clay between soil group 3Uga and 3Ugd and the variant 3Uga8 is due to the presence of a high percentage of coarse sand in the variant.

The clay percentages of the soil types of LU 5 show a wide variation. Generally the clay content peaks in the B horizon between 0.5-0.6 m and decreases in the BC and C horizons below.

The clay content of 6Dbh is much lower than 6Dbb. The presence of D horizons in 6Dbb explains the decrease in clay content at depth.

5.6.2 Comparisons of clay content between landscape units.

Clay percentage profiles for some cracking clays of LUs 1, 2 and 3 and some solodic-solodized solonetz of LUs 1, 2, 5 and 6 are shown in Figures 5.6.6 and 5.6.7.

Large differences between clay content occur between the cracking clays of LUs 1, 2 and 3.

Clay percentages of the B horizon of the solodic-solodized solonetz vary between 30 and 55 percent. The soil group of 2Dbb, 2Dya and 2Dyb has the highest percentage clay while soil type 6Dbh and soil group 5Dyc and 5Dyf have the lowest.

5.6.3 Clay activity ratios (CCR).

The clay activity ratio (CCR) or CEC to clay content ratio (meq/gm of clay) can be used as a rough guide to soil mineralogy (Landon 1984). Shaw et al. (1986) quotes CCR ratios of > 0.95 (strongly montmorillonitic), 0.55 to 0.75 (mixed kaolinite-montmorillonite) and < 0.55 (high proportion of kaolinite).

The clay activity ratios for some broad soil groups are shown in Table 5.6.1.

Using the criteria of Shaw et al. (1986), the cracking clays of LU 5, (CCR of 0.83 at 0.5 to 0.6) have a high proportion of montmorillonite while the clay in the non-calcic brown soil (CCR 0.43 at 0.5 to 0.6) has a high proportion of kaolinite. The ratios at 0.8 to 0.9 m are influenced by the inclusion of weathered parent material.

Coughlan (1979) used X-ray diffraction methods to determine the minerals present in < 2 Um fraction of a Koberinga (Hubble and Thompson 1953) (3Uga) and Barratta clay (Hubble and Thompson 1953) (2Ugd). The Koberinga was sampled from the survey area with the Barratta being sampled from the left bank of the Burdekin River. His studies showed that the Koberinga contained montomorillonite, kaolinite quartz and kaolinite-montmorillonite interstratification. The Barratta clay contained interstratified expanding layer silicates (or poorly crystalline montmorillonite), kaolonite, quartz and kaolinite montmorillonite interstratification. The clay activity ratios of the samples studied by Coughlan (1979) were 0.75 for the Koberinga and 0.62 for the Barratta clay.

Table 5.6.1 Clay activity ratios (m. eq. g^{-1} of clay) for some broad soil groups for three depths.

Soil group	Depth (m) 0.2-.0.3	0.5-.0.6	0.8-.0.9
Cracking clays of LU 1	0.6	0.61	0.63
Cracking clays of LU 2	0.58	0.6	0.59
Cracking clays of LU 3	0.64	0.66	0.64
Cracking clays of LU 5 (5Uga,b)	0.79	0.83	1.2
Non-calcic brown soil of LU 5	0.45	0.43	0.7

5.7 Plant available water capacity (PAWC)

Irrigation aims to ensure maximum crop yields by preventing water stress. The plant available water capacity (PAWC) of a soil is therefore an important factor in irrigation sheduling.

PAWC is obtained by measuring the differences between the upper soil water storage limit (field capacity concept) and the lower storage limit (permanent wilting point concept). Field measurements similar to those undertaken by Shaw and Yule (1978) and Gardner and Coughlan (1982) are the best means of determining PAWC. However measuring PAWC in the field is an involved process so predictive relationships are usually used to calculate PAWC.

Traditionally the difference between water held in the soil at -33 and -1500 kPa water potentials, using pressure plate apparatus, is used as a measure of the available water capacity. Gardner and Coughlan (1982) have shown that this approach can give erroneous results, especially for cracking clays and solodic-solodized solonetz. Shaw (personal communication) suggests the regression equations developed by Shaw and Yule (1978) using -1500 kPa moisture measurements are a more

appropriate estimation of PAWC. Depth of wetting for soils with restricted subsoil wetting has to be considered when using this equation. McCowan et al. (1976) and Mullins (1981) showed that for soils with restricted permeability in the subsoil the depth of wetting can be estimated from the depth to the concentration of salts. From the available EC measurements the depth of wetting of all solodic-solodized solonetz, except 6Dbb, was regarded as 0.5 to 0.6 m. Gardner and Coughlan (1982) measured PAWC in the field for selected soil profiles in the Burdekin River Irrigation Area.

Table 5.7.1 shows the predicted PAWC of the soil types or soil groups listed in Table 5.1.1 using the equation of Shaw and Yule (1978) using the -1500 kPa moisture content. The PAWC measured by Gardner and Coughlan (1982) is shown with the appropriate soil type. The predicted and measured rooting depths are also shown.

Table 5.7.1 Average predicted and measured PAWC (cm) for soil types or groups with the predicted and measured rooting depths.

Soil type or groups	PAWC (cm)*	Predicted rooting depth(m)	Measured PAWC (cm)**	Measured rooting depth(m)
1Uga, 1Ugd	12.71	0.9	11.4	1.0
1Ugf	12.78	0.9		
1Dyc	9.61	0.6	7.2	0.4
1Dda	9.63	0.6	6.3	0.5
2Uga, 2Ugh	13.0	0.9	10.4	1.2
2Ugd, 2Ugc	12.63	0.9		
2Dba	9.54	0.6		
2Dbb, 2Dyb, 2Dya	9.7	0.6	8.0	0.6
3Uga, 3Ugd	13.6	0.9	11.9	1.0
3Uga8	12.86	0.9		
5Dra	12.7	0.9	10.4	1.25
5Dya	11.68	0.9		
5Dyb	12.3	0.9		
5Uga, 5Ugb	12.64	0.9		
5Ugc	12.84	0.9		
5Dyc, 5Dye	9.5	0.9		
6Dbb	12.69	0.9		
6Dbh	9.4	0.6		

* from equation in Shaw and Yule (1978)
** comparative data from Gardner and Coughlan (1982)

The predicted PAWCs are higher than those measured by Gardner and Coughlan (1982) for the same soil type or group. The higher predicted PAWC for soil types 1Dda and 1Dyc may partly be explained by the greater depth to which the depth of wetting was estimated.

From Table 5.7.1 the equation of Shaw and Yule (1978) predicts similar PAWCs for the cracking clays and the solodic-solodized solonetz respectively independant of landscape unit.

5.8 Total phosphorus and potassium

Total phosphorus (P) and potassium (K) levels were averaged for all the soils analysed within each landscape unit and the results are shown in Table 5.8.1. Using the ratings of Bruce and Rayment (1982) low to medium values (0.005-0.05 percent) for total P occur in all soils of all landscape units.

Total K status varies from low (0.1 to 0.5 percent) in LUs 1 and 5 to high (1 to 3 percent) in LU 6. Medium levels (0.5 to 1 percent) are shown for LU 3 although the variations between the analysed profiles in this landscape unit is high with a standard deviation between .44 and .58. Total K status for soils of LU 2 is bordering the medium to high level with low coefficients of variations.

Values are highest in the 0-0.1 m layer than at other depths. The lowest values usually occur in the 0.5-0.6 m depth. Values at lower depths usually remain similar or increase. The higher value at 1.1-1.2 m in the soils of LU 5 may be due to the presence of BC or C horizons at this depth.

Little and Ward (1981) suggested that total potassium in soils formed on alluvium decreases with increasing age of the soil. The high levels in the soils of LU 6 support this theory as this landscape unit is considered the youngest in the survey area.

Table 5.8.1 Total phosphorus percent and potassium percent for the soils of five landscape units at five depths.

Landscape units	Depth (m)									
	0-0.1		0.2-0.3		0.5-0.6		0.8-0.9		1.1 -1.2	
	P%	K%	P%	K%	P%	K%	P%	K%	P%	K%
1	0.015	0.44	0.012	0.40	0.008	0.31	0.013	0.51	0.012	0.65
2	0.031	1.05	0.02	1.0	0.018	0.99	0.022	1.01	0.029	1.02
3	0.025	0.84	0.015	0.80	0.016	0.81	0.015	0.84	0.016	0.90
5	0.035	0.16	0.021	0.14	0.018	0.12	0.024	0.28	0.061	0.40
6	0.052	1.49	0.031	1.41	0.024	1.37	0.031	1.33	0.030	1.46

5.9 Extractable phosphorus

Phosphorus status for the bulk 0-0.1 m sample was determined by acid extraction (acid P) (Kerr and von Stieglitz 1938) and bicarbonate extraction (bicarb. P) (Colwell 1963). The results for both methods of analyses for the soil types or soil groups listed in Table 5.1.1 are

shown in Table 5.9.1. Results from both analyses are similar except for some discrepancies with 2Ugc, 2Ugd, 5Dya, 5Dyb, 5Uga, 5Ugb and 6Dbb. Acid P is considered more reliable on soils with pH less than 7.0 (von Stieglitz 1946). As these surface samples have pH less than 7.0 the results from this method would be considered more appropriate. Most soils are low to very low (Bruce and Rayment 1982) except 2Ugc, 2Ugd, 5Dya, 5Dyb and 5Uga and 5Ugb which have medium levels. Soil type 6Dbb has high levels.

These tests, although only providing a guide to phosphorus requirements, indicate that responses to phosphorus should be expected on all the analysed soil types with the exception of 6Dbb. Although very limited data is available for the 0.1-0.2 m depth for this survey, other studies (Baker (1977), Reid and Baker (1984) and Maltby in preparation) have shown that P status is lower than the surface 0-0.1 m. Levelling of soils will therefore expose horizons of lower P status which will require additional applications of phosphorus.

Table 5.9.1 Mean acid and bicarbonate extractable phosphorus levels for the 0-0.1 m bulk sample for the soil types or soil groups.

Soil type or soil group	Mean extractable P (ppm)	
	Acid	Bicarb.
1Uga, 1Ugd	6.5	7
1Ugf	5.5	6
1Dyc	3	2
1Dda	6	6
2Uga, 2Ugh	8.5	10.5
2Ugc, 2Ugd	21	11
2Dba	20	23
2Dya, 2Dyb and 2Dbb	8	12
3Uga, 3Ugd	11	3.5
3Uga8	10	9
5Dra	11	11
5Dya	24	12
5Dyb	21	16
5Uga, 5Ugb	21	12
5Ugc	6	5
5Dyc, 5Dyf	11	7
6Dbb	63	35
6Dbh	12	11

5.10 Carbon, nitrogen and sulphur

Organic carbon (C), total nitrogen (N), C/N ratios and total sulphur (S) are tabulated in Table 5.10.1 for the soil types and groups listed in Table 5.1.1.

Organic carbon (unadjusted Walkley and Black 1934) levels are low (Bruce and Rayment 1982) in all soil types or groups except 6Dbb which has medium levels. Total nitrogen levels in the surface samples are low for all soils except soil type 1Ugf and soil group 2Dya, 2Dyb and 2Dbb.

Carbon-nitrogen ratios (C:N) in the surface, range from 6 to 16 for all soils. Most lie in the range from 10 to 16 except for soil types 1Ugf and 5Dyb and soil group 2Dyb and 2Dbb which have values between 6 and 7. These lower values are lower than the values for C/N ratios of The Great Soil Groups of Australia quoted in Spain et al. (1983). The low values of organic carbon in comparison to the total N content for soil types 1Ugf and 5Dyb and soil group 2Dyb and 2Dbb suggest that responses to N fertiliser would be higher than for those other soil types with higher ratios.

Total S is regarded as a poor indicator of soil S deficiency but Andrew et al. (1974) has suggested that soils with < 0.013 percent total S may respond to sulphur applications. Using this criteria, soil types 1Ugf, 1Dyc, 1Dda, 2Dba and 6Dbh and soil groups 2Uga and 2Ugh, 3Uga and 3Ugd and 5Dyc and 5Dyf may respond to sulphur additions. Maltby and McShane (1988) using pot experimentation has shown that sulphur deficiency may occur over large areas of the right bank of the BRIA. He also suggests that sulphate leaching may occur under irrigation which will increase the problem of sulphur deficiency.

Generally, total S increases in the B horizon and then decreases at depth in the solodic-solodized solonetz. The cracking clays usually decrease with depth although some exceptions occur. Some high values of total S are associated with gypsum at depth.

Table 5.10.1 Mean organic carbon, total nitrogen, with carbon/nitrogen ratios and total sulphur for the 0-0.1 m depth for the soil types or groups.

Soil types or groups	Organic C percent	Total N percent	C/N ratios	Total S percent
1Uga,1Ugd	1.4	0.11	12	0.02
1Ugf	0.96	0.17	6	0.011
1Dyc	0.80	0.05	16	0.008
1Dda	1.1	0.07	10	0.011
2Uga,2Ugh	0.8	0.075	10	0.005
2Ugd,2Ugc	1.35	0.1	13	0.021
2Dba	1.0	0.08	12	0.012
2Dyb,2Dya 2Dbb	1.05	0.185	6	0.014
3Uga, 3Ugd	0.85	0.055	15	0.011
3Uga8	1.4	0.1	14	0.015
5Dra	0.99	0.073	14	0.018
5Dya	1.1	0.07	16	0.013
5Dyb	0.6	0.09	7	0.014
5Uga, 5Ugb	1.275	0.09	14	0.022

Table 5.10.1 (continued)

Soil types or groups	Organic C percent	Total N percent	C/N ratios	Total S percent
5Ugc	0.86	0.07	12	0.017
5Dyc, 5Dyf	0.91	0.06	15	0.01
6Dbh	1.2	0.10	12	0.014
6Dbb	2.1	0.15	14	0.009

5.11 Trace elements

Mean values for DTPA extractable trace elements Mn, Cu and Zn for the bulk surface sample for those soil types or soil groups listed in Table 5.1.1 analysed for these elements are listed in Table 5.11.1.

Viets and Lindsay (1973) suggest DTPA extractable copper and zinc values of 0.2 ppm and 0.5 ppm respectively as levels at which deficiences may occur. Using this criteria no surface soil is deficient in copper.

Zinc is very insoluble and thus immobile in soils. Zinc availability also is very dependant on pH. Bruce (1983) stated that the solubility of zinc decreases approximately 100 fold for each unit increase in pH. Mikkelsen and Kuo (1976) showed that zinc deficiences are common in alkali or calcareous soils with pH of 7.4 or higher.

DTPA zinc values at which deficiencies occur have been reported as 0.5 ppm (Viets and Lindsay 1973) and 0.5 ppm (pH < 7.0) or 0.8 (pH > 7.0) (Bruce and Rayment 1982). Using this criteria, with the exception of soil group 1Uga and 1Ugd, zinc may have to be applied to the cracking clays and solodic-solodized solonetz of LU 1 and LU 2 (values between 0.17 and 0.5 ppm). Maltby (in preparation) also recorded responses to zinc in pot trials for soil types 1Uga and 1Ugd. Soil groups 5Uga and 5Ugb and 5Dyc and 5Dyf and soil type 5Ugc have values between 0.1 and 0.46 and may also require applications of zinc. The lowest values for zinc in the analysed profiles are those of soil type 1Dyc and soil group 5Dyc and 5Dyf with values of 0.17 and 0.1 ppm respectively. Responses to zinc are expected to be more widespread when levelling is undertaken, especially if this operation exposes subsoils with pH > 7.4.

Manganese levels are in the medium to high range (Bruce and Rayment 1982) and therefore deficiencies are unlikely.

Table 5.11.1 Mean values for DTPA extractable elements, manganese, copper and zinc in ppm for the bulk surface sample 0-0.1 m for the soil types or soil groups.

Soil type or group	Elements (ppm)		
	Mn	Cu	Zn
1Uga, 1Ugd	33.5	1.65	1
1Ugf	54	1.3	0.47
1Dyc	30	0.83	0.17
1Dda	52	0.9	0.5
2Uga, 2Ugh	28.5	2.4	0.45
2Ugd	25	1.2	0.5
2Dyb, 2Dya	24	1.45	0.4
3Uga8	27	1.8	0.6
5Dra	62.5	1.5	0.8
5Uga, 5Ugb	36	1.8	0.46
5Ugc	70	1.4	0.3
5Dyc, 5Dyf	54.5	0.85	0.1
6Dbh	31	1.3	0.7
6Dbb	54	3.0	3.7

5.12 Gilgai-comparisons of mounds and depressions

Only three gilgaied sites (2Uga, 1Ugd, 1Ugf) were sampled from both the depression and mound. The pH of the depressions were lower than those of the mounds. However no consistency in the ECse and ESP profiles were apparent. Soil type 2Uga and 1Ugf had higher ECse values in the mound than the depression but the 1Ugd values were lower in the mound. The ESP of the mounds was slightly lower than that of the depression for 2Uga (except at 1.1-1.2 m) and 1Ugd but the opposite occurred for 1Ugf. Clay content of the mounds especially in the B horizon was lower in 2Uga but similar in the cracking clays of LU 1.

Generally nutrient levels were higher in the depression than the mounds although substantial differences were not apparent.

6 LAND USE

6.1 Present land use

6.1.1 Pastoral

About 85 percent of the survey area is used for the grazing of cattle on native pastures. Subdivisional fencing for grazing control is minimal and other cattle husbandry measures are also low.

6.1.2 Agriculture

Dryland cropping. Dryland cropping is restricted to small areas of soils of LUs 2, 3 and 5. Sorghum is the main crop although sunflowers and Dolichos have also been grown. Yields have been low.

Irrigated cropping. Rice has been grown on two properties (portion 59 and 388) on the black earths of LU 3. Water has been supplied from Clare Weir via a drain to Leichhardt Lagoon. A small area on and adjacent to the present Burdekin levee (LUs 6 and 2) is cropped and irrigated from underground sources. Here sugar-cane is grown on assigned land and crops such as egg-fruit, cucumbers, capsicums, pumpkins and maize have been grown.

The QDPI established an experimental site of 52 ha on soil types 3Ugd, 5Uga, 5Dra, 5Dya, 5Dyb and 5Dyc at the Fort Site (AMG of centroid, 529000E, 7809000N) in 1974 to determine the productivity of various crops, including rice, maize, sorghum, sunflower, navybeans and soybeans, under irrigation (Shaw et al. 1984). This project was discontinued by the Department in 1978 but irrigated cropping on this property has continued. In 1985 the QDPI in conjunction with QWRC also established a 10 ha block on soil type 1Dyc (Gaynor site, AMG of centroid, 529300E, 7805150N) to determine the irrigated cropping potential of this soil type. Maize and soybeans are being grown on the Leichhardt hydrosalinity research block (AMG of centroid, 532750E, 7809500N) which was established in 1986. The objectives of this project are outlined in Section 2.3.2.

6.2 Land suitability assessment

Each UMA was assessed for its suitability for growing sugar-cane, grain crops, small crops (horticultural), mangoes and rice under irrigation. The suitability was assessed on the condition of the land as it was found at the time of survey. The land suitability classifications used for this assessment contain five classes with the degree of suitability decreasing from class 1 to class 5. Land was considered less suitable as the severity of the limitations associated with this land increased, reflecting either:

a) reduced potential for crop production and/or;
b) increased inputs to achieve an acceptable level of crop production and/or;

c) increased inputs to prepare the land for irrigated agriculture and/or;
d) increased inputs to prevent land degradation.

The five classes are:
Class 1 Land suitable for irrigation with negligible limitations.
Class 2 Land suitable for irrigation with slight limitations.
Class 3 Land suitable for irrigation with moderate limitations.
Class 4 Land currently unsuitable for irrigation.
Class 5 Land unsuitable for irrigation.

The classes are defined in more detail in Appendix IV.

Class 4 land is regarded as currently unsuitable for irrigated agriculture for a particular crop due to the severity of one or a number of limiting factors. This land may be upgraded to a suitable class if either future agronomic, edaphic or engineering studies show it to be economically viable, or if prevailing economic conditions change, or if future technological advancements alter the level of management inputs required to achieve satisfactory productivity.

Class 5 land is regarded as unsuitable for irrigated agriculture for a particular crop because of such limitations as severe existing erosion, flooding, rockiness or a combination of other extreme limiting factors. Special studies, changes in economic conditions or increased technological advancements are not expected to show these lands to be suitable.

Two land suitability classifications were used, one for flood irrigation of rice, the other for furrow irrigation of sugar-cane, grain crops and small crops and low volume irrigation of mangoes. Sixteen limiting factors involving both soil and land attributes considered important for crop growth and irrigation management were used as the basis for determining the land suitability of a UMA for crops other than rice. Only six limiting factors were used to assess the suitability of a UMA for rice.

Subclasses were allocated to each limiting factor and usually ranged from 2 to 5 depending on the severity of the limitation.* The full range of subclasses was not considered necessary for all limiting factors of the classification. The land suitability class was determined by the most severe subclass of one or more of the limiting factors. Where a number of limiting factors had the same subclass, the effects of the interactions between these factors were appraised in order to determine whether this land should be downgraded to the next class.

The classification for crops other than rice was developed primarily for determining the suitability of land for grain crops. To allocate a separate suitability class for the other crops or crop groups (that is sugar-cane, small crops and mangoes), the effects of the limitations on the growth and management of each of the respective crops or crop groups were considered.

* Note that Class 1 has no subclasses

Flood irrigation of rice and furrow irrigation of sugar-cane, grain crops and small crops are the irrigation methods most likely to be used on the farms. The land suitability classes have therefore been determined for these methods of irrigation. However, trickle irrigation techniques are considered more appropriate for the growing of mangoes, so the suitability for mangoes has been determined for this low volume method of irrigation.

Furrow irrigation is not recommended on soil types 5Dra and 5Dya as these soils have high hydraulic conductivities. Losses to groundwater using furrow irrigation is expected to salinise the lower slopes of landscape unit 5 and adjoining soils of other landscape units. The suitability of UMAs of soil types 5Dra and 5Dya has therefore been determined for spray or trickle irrigation where losses to groundwater are expected to be much less.

The classifications have been developed for the irrigation method specified for each crop or crop group or for soil types 5Dra and 5Dya using current technology and management only. The suitability of a UMA may change if assessed for a different irrigation method and/or with more advanced technology or management.

The classifications used to determine land suitability for rice and for crops other than rice are shown in Appendix VI and V repectively. Table 6.2.1 lists subclasses of the limiting factors and land suitability classes for the soil types for each crop or crop group.

The suitability of a UMA may vary from that of the soil type due to the presence of other soil types within the UMA or variations of other soil and land attributes not usually associated with the soil type. A soil type may also have two suitability ratings if its attributes and those that determine the subclasses of a limitation extend over two subclasses.

Land suitability maps for sugar-cane, grain crops, small crops and mangoes, at a scale of 1:75 000, accompany this report.

Land suitability classes for specific UMAs of the study area as well as their respective areas are listed in Table 6.2.2. The total area of each land suitability class for the crops or crop groups is shown in Table 6.2.3.

Table 6.2.1 Subclasses of limiting factors and land suitability classes for sugar-cane, grain crops, small crops, mangoes and rice for soil types of Leichhardt Downs Section, Burdekin River Irrigation Area.

Soil type	Subclasses of limiting factors for crops other than rice																Land suitability classes				Subclasses of limiting factors for rice						Land suitability
	d	pb	ps	pd	pt	sa	so	t	n	r	g	w	e	f	i	o	Sugar cane	Grain crops	Small crops	Mangoes	t	g	f	p	sa	pd	Rice
1Uga, 1Ugd 1Ugc, 1Ugf			3				3*		2		2	3		2-3			2	3	4	4	2-3	2					2-3
1Uge			3	3			3	2	2	2	2		2				3	3	4	4	5	2		2			5
1Dya		4	3-4			3	3-4	2	2				2				3	4	4	5	2-4						2-4
1Dyb		3-4	3-4			3	4	2	2				2				3	4	4	5	2-4			5			5
1Dyc, 1Dda		3-4	3-4			3	3-4	2	2				2				3	4	4	5	2-4						2-4
1Dba		3-4	3-4				4	2	2				2				3	4	4	5	2-4						2-4
2Uga			3				3*		2					2-3			2	3	4	4				2			2
2Ugb			3						2		2	3		3			2	3	4	4		2	2	2			2
2Ugd, 2Ugg, 2Ugc			3						2		2	3		2-3			2	3	4	4		2		2			2
2Uge			3				3*		2		2	3		2-3			2	3	4	4		2		2			2
2Ugh			3				3		2		2	3		2-3			2	3	4	4		2		2			2
2Dyc		3	3				3		2		2	3		2-3			2	3	5	4		2	2			2	2
2Dba, 2Ddb		4	4				4		2								4	5	5	5	2					2	2
2Dbb, 2Dyb		3	3			3	3-4		2					2			2	3	4	4	2-3					2	2-3
2Dya		4	3-4			3	3-4		2					2			3	4	5	4	2						2
2Dbc, 2Dbd		2	3				3	2	2				2				2	3	3	3	2-3			3			3
2Dbe		3	3						2								2	3	4	4	2						2

Table 6.2.1 (Continued)

Soil type	Subclasses of limiting factors for crops other than rice																Land suitability classes				Subclasses of limiting factors for rice						Land suitability
	d	pb	ps	pd	pt	sa	so	t	n	r	g	w	e	f	i	o	Sugar cane	Grain crops	Small crops	Mangoes	t	g	f	p	sa	pd	Rice
3Uga, 3Uga8 3Ugk			3				3*		2		2	3		3			2	3	4	4		2	2	2			2
3Ugd, 3Uge			3						2		2	3		3			2	3	4	4		2	2	2			2
3Ugf			2						2					3			2	3	3	4			2	2			2
4Ucc			3	4	4			3	3				2		4		4	4	4	3	5			5			5
4Dyg		2-3	3				3*	2-3	3				3				4	4	4	4	5			5			5
4Dba		2-3	3				3-4	2-3	3				3				4	4	4	4	5			5			5
4Dyh		2-3	3				4	2	2-3				3				4	4	4	5	5			5			5
5Uga	2		3	**				2-3					3				2	3	4	4	5			5			5
5Ugb	2		3	**			3*	3					3				2	3	4	4	5			5			5
5Dra, 5Dya	2		3	**				3	2	2*			3		3		3	3	2	1	5			5			5
5Dyb			3					3	2				3				3	3	3	2	5			5			5
5Dyc		2-3	3-4				3-4	2	2				2-3			4	4	4	4	4	5			5			5
5Dyd		4	4				4	2	2				2			4	4	4	4	4	4-5			5			5
5Dyf - 5Dgc	2	2-3	3	3			3	2-3	2				3				3	3	4	4	5			5			5
6Ucc			3	4	3-4			2	2						4		3	4	3	2	3			5			5
6Dma, 6Umb, 6Gnd			2					2									2	2	2	2	3			5			5
6Dbc, 6Dbf		2	2					2									2	2	2	2	3			5			5
6Ugc			3					2				3		3			2	3	4	4			2	2		4	4
6Gna			3					2	2				2				2	3	2	2	4			5			5

Table 6.2.1 (Continued)

Soil type	Subclasses of limiting factors for crops other than rice																Land suitability classes				Subclasses of limiting factors for rice						Land suitability
	d	pb	ps	pd	pt	sa	so	t	n	r	g	w	e	f	i	o	Sugar	Grain	Small	Mangoes	t	g	f	p	sa	pd	Rice
6Gne			2					2	2				2				2	3	2	2	4			5			5
6Dbb		2	3				3*	2									2	3	3	3	2-3			5			5
6Uca			3	4	4			2	2							4	4	5	4	3	5			5			5
6Uga			2					3	2				3	4			3	4	4	4	5			5			5
6Drc		2	3						2								2	3	3	2	2			4			4
6Dbe		3	3					2									2	3	3	3	5			5			5
6Dbh		3	4				4	2	2				2				4	4	4	5	5			5			5
6Ufa, 6Ufd, 6Ufe			3	4				2				3	2	4			5	5	5	3	5			5			5
6Dba		2-3	3				3	2					2				2	3	3	3	4			3			4
6Dyb		2	3	4	2			2	2								3	4	4	3	3			5			5
6Dye			3	4	2			2	2				2				3	4	4	3	5			5			5
6Dyf		2	3					2	2								3	4	3	3	5			5			5
6Dyg		3	3				3	2	2				2				3	4	4	4	4			4			5
6Dyj		3	4	3			4	2	2				2	3			4	4	4	4	5			5			5
6Ddb		2	3	3			3	2	2				2				3	4	3	3	3			5			5
6Dda		3	3	4			3	2	2			3					3	4	3	3	3			5			5

* Some soil types do not have a rating as defined in the Land suitability classification.

** These soil types sometimes have a pd subclass of 4 depending on the presence of other soil types with markedly different permeabilities.

Table 6.2.2 Land suitability classes for unique map areas (UMAs), Leichhardt Downs Section, Burdekin River Irrigation Area.

UMA No.	UMA name	Area ha	Land suit. C	G	S	M	R	*
1	6UmaE	4.5	5	5	5	3	5	
2	4R	2.7	5	5	5	5	5	
3	4DygE	6.0	5	5	5	5	5	
4	2Uge 2Dyc	7.1	2	3	4	4	2	
5	4Dyg4	5.8	3	4	5	4	5	
6	6Dyh3	1.8	3	4	4	4	5	
7	6Dbb	6.5	2	3	2	2	5	
8	6DyhE	1.7	5	5	5	5	5	
9	2Dbb	18.0	3	3	4	4	5	
10	2Dbd	12.1	3	4	4	5	4	
11	4UccR	41.5	5	5	5	5	5	
12	2Sp	13.6	5	5	5	5	5	
13	1Ugd	5.8	2	3	4	4	2	
14	4Ucc1 4Dyg	8.4	5	5	5	5	5	
15	4Dyg4	7.4	3	4	4	5	5	
16	4DygR	1.3	4	4	4	4	5	
17	4Dyh	15.8	4	4	4	4	5	
18	4Dyh3	5.8	4	4	4	4	5	
19	2Ugc 2Dya	14.1	3	4	5	4	3	
20	2Ugc	13.3	3	4	4	4	3	
21	6Dbb	1.4	2	3	4	4	5	
22	6Dbb	1.5	2	3	4	4	5	
23	6Dbb	13.1	2	3	2	2	5	
24	6Sp	0.9	5	5	5	5	5	
25	2Ugc	17.9	3	4	5	5	3	
26	2Ugc	1.2	4	4	5	5	3	
27	2Dya	5.3	3	4	5	4	3	
29	6Dyb1 4Dyg	4.2	4	4	5	4	5	
30	4Dyh3	7.6	4	4	4	4	5	
31	2Ugc	17.1	2	3	4	4	3	
32	2Dbd	2.5	3	4	4	4	3	
33	6Dbb3	8.5	3	3	3	3	5	
34	2Uge 2Dyb	31.0	3	4	4	4	3	
35	2Ugc	5.6	2	3	4	4	3	
36	2Uga	4.7	2	3	4	4	3	
37	1Ugd	45.6	3	3	4	4	3	
38	1Uga	38.9	2	3	4	4	3	
39	5Dyd	13.8	4	4	4	4	5	
41	5Dya	4.1	3	3	2	1	5	
42	5Dra	44.1	3	3	2	1	5	
43	5Dyf 5Ugc	9.3	3	4	4	4	5	
45	1Dya	9.4	4	4	5	5	5	
46	1Ugf	2.3	3	3	4	4	5	
48	5Dyc	8.6	4	4	4	4	5	
49	1Dba	2.7	4	4	4	5	4	
50	5Dyc1	5.9	4	4	4	4	5	
51	5Dyd 5Uga	6.9	4	4	4	4	5	
52	1Uga	37.3	2	3	4	4	3	
53	1Dyc	18.8	4	4	4	5	3	
54	1Ugd	26.4	3	3	4	4	3	
55	5Uga	2.3	3	3	4	4	5	
56	1Ugf	1.6	3	4	4	4	3	
57	3Uga	463.2	2	3	4	4	2	
58	5Dyc 5Uga	3.9	4	4	4	4	5	
59	1Ugd	6.0	3	3	4	4	3	
60	1Ugc	2.7	2	3	4	4	4	
61	1Ugd	3.8	3	3	4	4	4	
62	5Dyd	5.1	4	4	4	4	5	
64	2Dbb	17.2	2	4	4	4	2	
65	2Dyc	23.3	2	3	5	4	2	
66	2Ugg	8.2	2	3	4	4	2	
67	2Ugc	17.0	2	3	4	4	2	
68	4Dyh	43.2	4	4	4	4	5	
69	4Dba	4.4	4	4	4	4	5	
70	3Uga	15.3	2	3	4	4	2	
71	6Dyj	4.9	4	4	4	5	5	
72	6Dyh	1.3	3	4	4	4	5	
73	2Ddb	3.5	4	4	5	5	4	
74	6Dyj	1.0	4	4	4	4	5	
75	1Dda	111.1	3	4	4	5	4	
76	4Dyh	12.2	4	4	4	4	5	
77	6Dyf	15.0	3	4	3	3	5	
78	6Dye	15.8	5	5	5	4	5	
79	6Dyf	2.7	3	4	3	3	5	
80	4Dyg	18.8	3	4	4	4	5	
81	6Dyg	10.8	3	4	4	4	5	
82	6Dda	0.8	2	3	3	3	4	
83	4Dyh3	0.5	4	4	4	4	5	
84	2Dyc	9.6	3	4	5	4	3	
85	6Dyg	12.0	3	4	4	4	5	
86	6Ufd	7.1	5	5	5	3	5	
87	1Uga	72.3	2	3	5	4	3	
88	1Dyc	14.3	3	4	4	5	4	
89	6Dba	6.1	3	4	4	3	4	
90	1Dda	1.6	3	4	4	5	5	
91	6Ufa	8.6	5	5	5	3	5	
92	1Ugd	24.0	2	3	4	4	4	
93	1Dyc	11.0	3	4	4	5	4	
94	6Dda	6.4	3	4	4	3	5	
95	1Dda	1.8	3	4	4	5	4	
96	1Ugc	9.9	2	3	4	4	4	
97	5Dya	1.6	3	3	2	1	5	
98	2Dyb	87.0	2	3	4	4	3	
99	1Dyc	28.2	3	4	4	5	4	
100	1Dda	4.1	4	4	4	5	4	
101	1Dyc 1Uga	5.0	4	4	4	5	5	
102	1Dyc	4.7	4	4	4	5	5	
103	1Uge	5.9	3	3	4	4	5	
104	5Dyb	4.6	3	4	3	2	5	
105	5Dyc	1.5	4	4	4	4	5	
106	1Ugd	6.6	2	3	4	4	5	
107	1Uga	42.7	2	3	4	4	4	
108	1Dyc	14.2	3	4	4	5	5	
109	1Uge	6.8	3	3	4	4	5	
110	5Dyc	0.5	4	4	4	4	5	
111	1Dyc	0.8	3	4	4	5	4	
112	1Dyc	11.3	3	4	4	5	5	
113	1Ugd	7.0	2	3	5	4	4	

* C- Sugar-cane G- Grain crops S- Small crops M- Mangoes R- Rice

Table 6.2.2 (continued)

UMA No.	UMA name	Area ha	Land suit. C	G	S	M	R
114	1Dyc	0.6	3	4	4	5	5
115	2Ugg	12.1	2	3	4	4	2
116	1Ugf	3.4	2	3	5	4	4
117	2Dyb	77.0	2	3	4	4	2
118	2Dya	50.4	3	4	5	4	3
119	2Ugc 2Dya	14.2	3	4	5	4	3
120	2Uge	74.2	2	3	4	4	2
121	6Dyg	10.7	3	4	4	4	5
122	2Dbe	9.3	2	4	4	4	3
123	2Ugd	20.8	2	3	4	4	2
124	2Ugc 2Dya	11.8	3	4	5	4	2
125	2Ugg	118.1	2	3	4	4	2
126	2Ugh	28.8	2	3	4	4	2
127	2Dbb	11.9	2	3	4	4	5
128	2Dya	12.7	3	4	5	4	2
129	2Dyb 2Uga	2.6	3	4	4	4	3
130	2Dyb	16.9	2	3	4	4	3
131	2Dya	33.6	3	4	5	4	2
132	2Ugd	6.1	2	3	5	4	3
133	2Ugg	44.7	2	3	4	4	2
134	1Ugc 1Dyc	14.2	3	4	4	5	3
135	1Ugd	10.6	2	3	4	4	3
137	5Dyd	2.1	4	4	4	4	5
138	5Dyc	26.6	4	4	4	4	5
139	1Dyc	94.0	3	4	4	5	4
140	1Dyb	9.8	3	4	4	5	5
141	1Dya	23.6	3	4	4	5	4
142	5Dyd	5.4	4	4	4	4	5
143	1Dda	12.9	3	4	4	5	5
144	5Dyc	0.6	4	4	4	4	5
145	1Dyc	2.4	3	4	4	5	3
146	1Ugf	67.7	2	3	4	4	4
147	1Uga	12.1	2	3	4	4	4
148	1Dda	0.7	3	4	4	5	4
149	1Dda	31.3	3	4	4	5	4
150	1Ugd	7.9	2	3	4	4	5
151	1Uge	3.9	3	4	4	4	5
152	1Dda 1Ugc	8.4	3	4	4	5	5
153	1Ugd	2.1	2	4	4	4	4
154	1Ugc	3.7	2	3	4	4	4
155	1Dyc	12.1	3	4	4	5	4
156	5Dyd	6.4	4	4	4	4	5
157	1Dyc	15.8	3	4	4	5	5
158	5Dyd	1.0	4	4	4	4	5
159	1Ugc 1Dyc	3.9	3	4	4	5	5
160	5Dyc	2.7	4	4	4	4	5
161	1Uga	21.3	2	3	4	4	2
162	3Uga	34.9	2	3	4	4	2
163	6Dbf2	20.1	3	4	2	2	5
164	6Ddb	1.5	3	4	3	4	5
165	6Uca	1.2	4	5	4	3	5
166	6Dda	2.6	3	4	3	3	5
167	6Dda	7.0	3	3	3	3	5
168	1Dda	11.0	3	4	4	5	5
169	6Uca	2.9	5	5	5	5	5
170	6Uca	1.5	5	5	5	5	5
171	6Dda	2.0	3	4	3	3	5
172	6Dbf	5.2	3	4	3	3	5
173	6Dyh	4.1	3	4	4	3	5
174	6Uca	15.1	4	5	4	3	5
175	6Dda	12.6	3	4	3	3	5
176	6Dbf2	2.7	3	4	3	3	5
177	6Dda	2.5	3	4	3	3	5
178	6Dda	7.2	3	4	3	3	5
179	6Dyh	10.5	3	4	4	3	5
180	6Dda	2.6	3	4	3	3	5
181	6Dyb2	20.7	4	4	4	3	5
182	6Ucc	0.6	4	5	4	3	5
183	6Dda	2.2	3	4	3	3	5
184	6Dyg	4.8	3	4	4	4	5
185	6Dbf2	3.0	4	5	3	3	5
186	6Uca	6.4	4	5	4	3	5
187	6Dda	1.7	3	4	3	3	5
188	6Dyb	4.9	3	4	4	3	5
189	6Dyh	3.0	3	4	4	3	5
190	6Dda	1.1	3	4	3	3	5
191	1Dda	5.3	3	4	4	5	5
192	6Dyh2 6Dyg2	17.8	3	4	4	3	5
193	1Dda	6.4	3	4	4	5	5
194	6Ddb	1.8	3	4	3	4	5
195	6Uca	6.2	4	5	4	3	5
196	6Dyh2	6.8	4	4	4	3	5
197	6Dda	3.0	3	4	4	4	5
198	6Dyb	1.3	4	4	4	3	5
199	1Uga	23.9	2	3	4	4	4
200	5Dya	4.8	3	3	2	1	5
201	5Dra	9.1	3	3	3	1	5
202	6Dda	4.4	3	4	3	3	5
203	1Ugc	10.8	2	3	4	4	4
204	3Uga	21.2	2	3	4	4	2
205	3Uga8	51.8	2	3	4	4	2
206	1Uga	19.3	2	3	4	4	2
207	1Dyc	5.6	4	4	4	5	4
208	5DyaR	3.2	5	5	5	3	5
209	3Uga8	49.7	2	3	4	4	2
210	5Dyb	1.6	4	4	4	3	5
213	3UgdE	45.2	5	5	5	5	5
214	1Ugd	2.9	2	3	5	4	2
215	6Dda	0.4	3	4	3	3	5
216	3Uge	93.8	2	3	4	4	2
217	6Gnd2	2.7	4	4	4	3	5
218	5Dyc	1.8	4	4	4	4	5
219	6Dye	16.6	3	4	4	3	5
220	6Uca	8.5	4	5	4	3	5
221	6Ddb	37.6	3	4	3	4	5
222	5R	1.6	5	5	5	5	5
223	6Ddb	14.5	3	4	3	4	5
224	6Uca	9.0	4	5	4	3	5
225	6Dyh	8.3	3	4	4	3	5
226	5Dyd	2.5	4	4	4	4	5
227	2Ugh	4.5	2	3	4	4	2
228	3Ugd	72.4	2	3	4	4	2
229	2Ugc	7.5	2	3	4	4	2
230	2Uge	11.0	2	3	4	4	2

Table 6.2.2 (continued)

UMA No.	UMA name	Area ha	Land suit. C	G	S	M	R
231	2Uga	3.4	2	3	4	4	2
232	2Ugc 2Dya	24.1	3	4	5	4	2
233	2Dbb	52.8	2	3	4	4	5
234	6Drc	7.3	2	3	3	2	5
235	2Ugc	5.2	3	4	5	4	2
236	2Dyb 2Uge	41.6	3	4	4	4	3
237	2Ugh	14.5	2	3	4	4	2
238	2Uga	49.5	2	3	4	4	2
239	2UgaE	17.3	5	5	5	5	5
240	6Dbh	96.4	4	4	4	5	5
241	2Dyc	18.2	2	3	5	4	4
242	2Dyb	11.2	2	3	4	4	2
243	2Dya	19.7	3	4	5	4	2
244	2Uge	13.3	2	3	4	4	2
245	6Dba	47.7	2	3	3	3	4
246	2Ugg	20.8	2	3	4	4	2
247	6Gne	1.0	4	4	3	3	5
248	6Ufe	28.6	5	5	5	3	5
249	6Ufe 6Dyh	5.9	5	5	5	4	5
250	6Dda2	0.6	3	4	4	3	5
251	1Uga	2.5	3	4	4	4	4
252	6Dye	3.3	4	4	4	3	5
253	6Uma2	36.1	2	2	2	2	5
254	2Dbc	34.6	2	3	2	3	3
255	2Dbd	15.4	2	3	3	3	5
256	2Dyb	11.4	2	3	4	4	5
257	2Uge	7.1	2	3	4	4	3
258	2Dyc	8.7	3	3	5	4	3
259	2Dyb	11.5	2	3	4	4	2
260	2Dya	22.8	3	4	5	4	2
261	2Dyb	7.4	2	3	4	4	2
262	2DbbE	6.8	5	5	5	5	5
263	2Ugd	6.9	2	3	5	4	2
264	2Dyb	32.5	2	3	4	4	2
265	2Dba	1.0	4	5	5	5	2
266	6Drc	3.0	2	3	3	2	4
267	6Drc	1.1	2	3	3	2	4
268	2Dba	0.8	4	5	5	5	2
269	2DbbE	0.7	5	5	5	5	5
270	2DbbE	1.1	5	5	5	5	5
271	2DyaE	6.1	5	5	5	5	5
274	2Dya	1.6	5	5	5	5	4
275	2Dyb	4.2	3	4	5	4	5
276	6Drc	0.7	2	3	3	2	5
277	2Dba	1.1	4	5	5	5	2
278	2Ugd 2Dba	0.7	4	5	5	5	2
279	2Dba	0.5	4	5	5	5	2
280	2Dba	3.0	4	5	5	5	2
281	2UggE 2DycE	4.3	5	5	5	5	5
282	2Ugg	8.0	3	4	4	4	3
283	2DbbE	1.4	5	5	5	5	5
284	2Dya	0.7	5	5	5	5	5
285	2Dya	13.0	3	4	5	4	5
286	2Ugd	0.8	2	3	5	4	2
287	2Dba 2Dya	22.2	4	5	5	5	4
288	5DraR	3.8	5	5	5	5	5
289	2Dyb	4.5	2	3	4	4	2
290	5UgaE	6.1	5	5	5	5	5
291	5Uga	1.9	3	4	5	4	5
292	5Dya	8.3	3	3	3	1	5
293	5Dra	9.6	3	3	2	1	5
294	5Dya	63.4	3	3	2	1	5
295	5Dra	72.0	3	3	2	1	5
296	5Dyc	9.1	4	4	4	4	5
297	5Dya	3.4	3	3	2	1	5
298	5Dyd	2.5	4	4	4	4	5
299	5R	3.1	5	5	5	5	5
300	5R E	10.9	5	5	5	5	5
301	2Dba	11.0	4	5	5	5	5
302	2Uga	16.3	2	3	4	4	2
303	2Dyb	109.5	3	4	4	4	4
304	2Dya	2.8	3	4	5	4	4
305	2Dya	19.6	3	4	5	4	2
306	2Ugh	37.0	2	3	4	4	2
307	2DybE	71.3	5	5	5	5	5
308	2Dyb	2.5	3	4	4	4	5
309	2Dya	2.2	3	4	5	4	4
310	2Dyb	1.7	2	3	4	4	2
311	2Dyb 2Uge	12.0	2	3	4	4	2
312	2Ugg	14.1	2	3	4	4	3
313	2Ugg	7.4	2	3	4	4	2
314	2Uga	3.5	2	3	4	4	2
315	2DybE	4.3	5	5	5	5	5
316	2Ugd 2Dba	6.0	3	4	5	5	3
317	2Dba	1.2	4	5	5	5	3
318	2DbeE	0.7	5	5	5	5	5
319	2Dbe	0.6	5	5	5	5	5
320	6Drc	6.1	2	3	3	2	5
321	6DrcE	0.5	5	5	5	5	5
322	6UgaE	0.9	5	5	5	5	5
323	6UgaE	0.7	5	5	5	5	5
324	2Dyb	30.9	2	3	4	4	2
325	6Drc	2.1	2	3	3	2	4
326	2Dbb	10.1	2	3	4	4	5
327	2Uge	13.3	3	4	5	4	5
328	2Ugb	3.3	2	3	4	4	2
329	2UgbE	2.1	5	5	5	5	5
330	2Ugg	13.2	2	3	4	4	2
331	2Ugb	17.2	2	3	4	4	2
332	3Ugd	7.7	2	3	4	4	2
333	2Dyc	1.3	2	3	5	4	2
334	2Dbc	2.3	3	3	4	4	3
335	2Dyb	1.5	2	3	4	4	2
336	2Uge	1.2	2	3	4	4	2
337	2Dyc 2Ugg	4.4	3	4	5	4	3
338	2UgbE	6.5	5	5	5	5	5
339	2Ugb	1.7	2	3	5	4	3
340	5Dyb	13.8	3	3	3	2	5
341	5Dra	187.8	3	3	2	1	5
342	5Dya	10.5	3	3	2	1	5
343	5Dyb 5Dyc	15.2	4	4	4	4	5
344	6Ddb	0.5	3	4	3	4	5
345	6Drc	5.9	2	3	3	2	5
346	1Ugd 1Dyc	10.1	3	4	4	5	3

Table 6.2.2 (continued)

UMA No.	UMA name		Area ha	Land suit. C	G	S	M	R
347	6Gnd		68.2	3	4	3	2	5
348	5Dyb3		6.8	4	4	4	3	5
349	5Dyc3		6.7	4	4	4	4	5
350	5Dyc		1.6	4	4	4	4	5
351	1Ugc		2.5	2	3	4	4	5
352	3Uge		10.5	2	3	4	4	2
353	2Ugg		28.1	2	3	4	4	2
354	2Ugh		40.6	2	3	4	4	2
355	2Uge		21.0	2	3	4	4	2
356	6Dbh		25.1	4	4	4	5	5
357	2Dbb		3.8	3	4	4	4	4
358	2DbbE		2.3	5	5	5	5	5
359	5Dyc	5Uga	1.3	4	4	4	4	5
360	5Dra	5Uga	2.2	3	4	4	3	5
361	5Dya		7.8	3	3	2	1	5
362	5Dyc		37.9	4	4	4	4	5
363	2Ddb		1.2	4	5	5	5	4
364	2Uga		2.9	3	3	4	4	4
365	2Dba	2Ugd	5.4	5	5	5	5	4
366	2Dba		1.4	5	5	5	5	4
367	2DdbE		2.4	5	5	5	5	5
368	6Dbh2		2.3	5	5	5	5	5
369	2Ugg		3.9	3	3	4	4	4
370	2Ugg		1.2	4	4	4	4	4
371	5Dyd		0.9	4	4	4	4	5
372	6Dyg		1.4	5	5	5	5	5
373	2Ugh	2Ddb	1.4	3	4	5	5	3
374	2Ugh	2Ddb	0.7	3	4	5	5	3
375	6Uga		10.4	3	4	4	4	5
376	6Dyg		2.4	3	4	4	4	5
377	2Dya		6.8	3	4	5	4	2
378	2Ugh		3.1	2	3	4	4	2
379	2Dbb		6.7	3	3	4	4	5
380	5Dyc		35.4	4	4	4	4	5
381	5Dra		179.5	3	3	2	1	5
382	1Ugf		2.0	2	3	5	5	5
383	2UgeE		2.7	5	5	5	5	5
384	2Uge		4.6	2	3	5	4	3
385	2Dyb		12.4	2	3	4	4	2
386	1UgaE		13.4	5	5	5	5	5
387	2Ugg		29.4	2	3	4	4	2
388	6UmaE		24.6	5	5	5	5	5
389	1Uga		11.2	3	4	5	4	3
390	5Dyb		8.0	3	3	3	2	5
391	5Dyb		20.6	4	4	4	3	5
392	5Uga	5Dra	12.4	3	4	4	4	5
393	5Dra		5.8	3	4	3	2	5
394	5Uga		3.7	3	4	4	4	5
395	5Dra		94.1	3	3	2	1	5
396	1Ugd		173.8	2	3	4	4	3
397	6DbeE		4.2	5	5	5	5	5
398	2Uge		1.7	2	3	4	4	3
399	5Dyc		4.3	4	4	4	4	5
400	2DbdE		2.0	5	5	5	5	5
401	2DybE		0.7	5	5	5	5	5
402	2Uga		2.1	2	3	4	4	3
403	5Uga		1.0	3	4	4	4	5
404	3Ugk		27.9	2	3	4	4	3
405	5Dyc		13.1	4	4	4	4	5
406	5Dyd		3.1	4	4	4	4	5
407	1Ugd		9.1	2	3	4	4	2
408	3Uga8		9.7	2	3	4	4	3
409	5Dyb		0.9	4	4	4	3	5
410	5Dyc		13.5	4	4	4	4	5
411	5Dra	5Ugb	19.9	3	4	4	3	5
412	5Uga		54.0	2	3	4	4	5
413	5Dra		1.2	3	4	4	4	5
414	5Dra		0.5	3	4	4	4	5
415	5Ugb		3.3	3	4	4	4	5
416	5Dra		1.2	3	4	4	4	5
417	5Dra		2.2	3	4	4	4	5
418	5Ugb		2.8	3	4	4	4	5
419	5Ugb	5Dra	5.1	3	4	4	4	5
420	5Dyf	5Ugc	6.2	3	3	4	4	5
421	5Ugb		2.4	3	4	4	4	5
422	5Dyf	5Ugc	1.7	3	3	4	4	5
423	5Uga		25.9	3	4	4	4	5
424	5Dyf	5Ugc	5.8	3	3	4	4	5
425	5Dyc		5.3	4	4	4	4	5
426	5Ugb		1.7	3	4	4	4	5
427	5Dra		21.8	3	3	2	1	5
428	5Dyc		4.2	4	4	4	4	5
429	5Dyb		1.5	4	4	4	4	5
430	5Dyc		0.8	4	4	4	4	5
431	5Ugb		8.5	3	4	4	4	5
432	5Uga		2.7	3	4	4	4	5
433	5Dyc		2.9	4	4	4	4	5
434	5Uga		15.7	2	3	4	4	5
435	5Dra		20.6	3	3	2	1	5
436	5Dyc		1.6	4	4	4	4	5
437	5Ugb		2.0	2	3	4	4	5
438	5Dra		1.1	3	4	3	3	5
439	3Ugd		20.8	4	4	5	5	3
440	3Ugf		29.1	2	3	3	4	3
441	1Uga		3.4	3	3	4	4	3
442	1Ugc		2.4	2	3	4	4	3
443	1Ugc		2.9	2	3	4	4	2
444	1Dyc		16.8	4	4	4	5	3
446	5Dya		5.9	3	3	2	1	5
447	5Ugb		0.9	2	3	4	4	5
448	5Dyb		4.4	3	3	3	2	5
449	5Dyc		5.1	4	4	4	4	5
450	5Dra		5.3	3	3	2	1	5
451	5Dyc		6.8	4	4	4	4	5
452	5Dra		12.4	3	3	2	1	5
453	5Dyc		10.5	4	4	4	4	5
454	5Dyc	1Uga	4.0	4	4	4	4	5
455	5Dyc		1.8	4	4	4	4	5
456	5Dyf	5Ugc	3.0	3	3	4	4	5
457	5Dra		6.0	3	3	2	1	5
458	6Dbc		4.4	3	3	2	2	5
459	5Dyf	5Ugc	39.9	3	3	4	4	5
460	5Dra		2.9	3	4	4	3	5
461	5Uga		6.7	3	4	4	4	5

Table 6.2.2 (continued)

UMA No.	UMA name		Area ha	Land suit. C	G	S	M	R
462	5Dra		4.3	3	4	3	2	5
463	5Uga		3.7	3	4	4	4	5
464	5Dyc		4.5	4	4	4	4	5
465	5Dra		2.2	3	4	3	2	5
466	5Ugb		1.4	3	4	4	4	5
467	5Uga		0.8	3	4	4	4	5
468	5Dyc		1.2	4	4	4	4	5
469	1Uga		6.6	3	3	4	4	3
470	1Ugd		1.7	3	3	4	4	3
471	1DycE		2.3	5	5	5	5	5
472	1UgcE		2.8	5	5	5	5	5
473	1Dyc		1.1	4	4	4	5	3
474	1Ugc		9.4	4	4	4	5	3
475	5Dyc		14.0	4	4	4	4	5
476	5Dyb		16.9	3	3	3	2	5
477	1Dyc		3.5	3	4	4	5	2
478	1UgfE		6.8	5	5	5	5	5
479	1Dyc		10.7	3	4	4	5	3
480	5Dra		9.5	3	3	2	2	5
481	5Dyc		3.2	4	4	4	4	5
482	5Dra		22.6	3	3	2	1	5
483	5Dra		44.2	2	3	2	1	5
484	5Dya		1.8	3	3	2	1	5
485	5Dra		7.5	3	3	3	2	5
486	5Dyc		2.7	4	4	4	4	5
487	5Dyb		3.2	3	4	4	4	5
488	5Dra		15.3	3	3	3	2	5
489	5Dya		10.6	3	3	3	2	5
490	5Dra		2.9	3	4	3	3	5
491	5Dyc		2.8	4	4	4	4	5
492	1Dyc		3.4	3	4	4	5	3
493	2Uge		6.3	2	3	4	4	5
494	1Dyc		24.3	3	4	4	5	4
495	1Ugf		4.4	2	3	4	4	3
496	5Dyb		14.4	3	3	3	2	5
497	5Uga		0.9	3	4	4	4	5
498	5Dra		0.6	3	4	3	2	5
499	5Uga		6.0	3	4	4	4	5
500	5Dyc		1.7	4	4	4	4	5
501	5Dra		1.0	4	4	3	3	5
502	5Dra		0.5	4	4	4	4	5
503	5Uga		4.0	3	4	4	4	5
504	5Dyc	1Ugd	4.9	4	4	4	4	5
505	5Dra		47.3	3	3	2	1	5
506	5Dyc	5Uga	4.9	4	4	4	4	5
507	5Dyb		3.0	4	4	4	3	5
508	5Dyc		3.9	4	4	4	4	5
509	1Dyc		3.0	3	4	4	5	3
510	1Dyc		2.9	3	4	4	5	3
511	1Dyc		0.6	3	4	4	5	3
512	1Dyc		8.0	3	4	4	5	4
513	5Dyc		26.4	4	4	4	4	5
514	5Dra		1.3	4	4	4	4	5
515	5Dyb		2.9	4	4	4	3	5
516	5Dyc		2.7	4	4	4	4	5
517	5Uga	5Dyc	2.2	4	4	4	4	5
518	5Dyc		6.2	4	4	4	4	5
519	5Dyb		2.1	3	3	3	2	5
520	5Dyc		12.9	4	4	4	4	5
521	1Ugf		3.2	3	3	4	4	5
522	5Uga		2.4	3	4	4	4	5
523	5Uga		2.5	3	4	4	4	5
524	5Dyc		2.3	4	4	4	4	5
525	5Uga		1.0	4	4	4	4	5
526	5Uga		6.4	3	4	4	4	5
527	5Dra		0.5	3	3	4	4	5
528	5Dyc		4.5	4	4	4	4	5
529	5Dra		23.4	3	3	2	1	5
530	5Uga		1.0	3	4	4	4	5
531	1Ugd		8.5	3	4	4	5	4
532	5Dyc		8.0	4	4	4	4	5
533	5Dyc		2.8	4	4	4	4	5
534	5Dyc	5Uga	2.0	4	4	4	4	5
535	5Uga		10.5	3	4	4	4	5
536	5Uga		3.9	3	4	4	4	5
537	5Uga		20.7	2	3	4	4	5
538	5Dra		49.0	3	3	2	1	5
539	5Dra		10.5	3	4	4	3	5
540	5Uga	5Dra	8.0	3	4	4	4	5
541	5Dra	5Uga	3.1	3	4	4	4	5
542	5Uga		1.6	3	4	4	4	5
543	5Dyc		8.3	4	4	4	4	5
544	5Dra		2.8	3	4	3	3	5
545	5Dra	5Uga	1.3	3	4	4	3	5
546	5Dra		21.7	3	4	3	2	5
547	5Ugb		20.6	2	3	4	4	5
548	5Dyc		8.5	4	4	4	4	5
549	5Dyc		3.1	4	4	4	4	5
550	5Ugb		6.1	2	3	4	4	5
551	5Dyc		7.4	4	4	4	4	5
552	1Uga		5.7	3	4	4	4	5
553	5Uga	5Dyc	3.3	4	4	4	4	5
554	5Dra	5Uga	6.0	3	4	4	4	5
555	5Uga		11.7	3	4	4	4	5
556	5Uga		3.4	3	4	4	4	5
557	5Dyc	5Uga	1.4	4	4	4	4	5
558	1Ugd		11.6	2	3	4	4	3
559	1Ugf		145.1	2	3	4	4	2
560	1Dyc		9.4	4	4	4	5	2
561	1Dyc		4.9	4	4	4	5	2
562	5Dyc		4.3	4	4	4	4	5
563	1Dyc		27.4	4	4	4	5	4
564	5Uga		31.7	2	3	4	4	5
565	5Uga	5Dra	3.2	3	4	4	4	5
566	5Dra		2.5	3	4	3	3	5
567	5Uga	5Dra	9.0	3	4	4	4	5
568	1Dyc		12.9	3	4	4	5	4
569	5Dra		3.3	3	4	3	3	5
570	1Ugd		2.4	2	3	4	4	4
571	5Uga		9.3	3	4	4	4	5
572	5Dra		1.0	3	4	3	3	5
573	5DraR		3.1	5	5	5	5	5
574	5Dyb		2.0	4	4	4	4	5
575	5Dyc		2.2	4	4	4	4	5

Table 6.2.2 (continued)

UMA No.	UMA name		Area ha	Land suit. C	G	S	M	R
576	1Uga		3.1	2	3	4	4	4
577	6Uga		8.9	5	5	5	5	5
578	2Dyb		62.9	2	3	4	4	5
579	5Dra		9.9	3	3	2	2	5
580	6Dyj		2.9	4	4	4	4	5
581	1Uga		15.4	2	3	4	4	2
582	1Ugc		10.6	2	3	4	4	2
583	5Dra		0.7	3	4	4	4	5
584	6Ufa	6Uga	44.6	5	5	5	5	5
585	6Dyg		5.5	3	4	4	4	5
586	5Uga		1.9	3	4	4	4	5
587	6Dyj		6.4	4	4	4	4	5
588	5Dyc		3.2	4	4	4	4	5
589	6Dyg		4.3	3	4	4	4	5
590	1Ugc		1.2	4	4	4	4	5
591	5Dyc		5.2	4	4	4	4	5
592	1Uga		6.3	3	3	4	4	4
593	1Dyc		3.7	3	4	4	5	4
594	1Dyc		1.2	4	4	5	5	5
595	6Gna		1.2	4	4	4	4	5
596	1Dyc		2.3	4	4	5	5	5
597	5Dyb		1.1	4	4	4	4	5
598	6Dyj		7.5	4	4	4	4	5
599	1Uga		12.5	3	3	4	4	4
600	1Ugc		3.7	3	3	4	4	4
601	5Dra1	5R	3.7	5	5	5	5	5
602	5Dyc		1.4	5	5	5	5	5
603	6Dda		9.1	3	3	3	3	5
604	1Dyc		1.6	3	4	4	5	4
605	5Uga		5.3	3	4	4	4	5
606	5DycE		1.8	5	5	5	5	5
607	5Dyc		2.0	4	4	4	4	5
608	5Uga		2.0	3	4	4	4	5
609	5Dyc		9.7	4	4	4	4	5
610	1Ugc		0.4	4	4	4	4	5
611	5Dyb	5Uga	1.9	4	4	4	4	5
612	5Dra		0.9	4	4	3	3	5
613	5Dyc		5.0	4	4	4	4	5
614	5Ugb		1.8	3	4	4	4	5
615	6Uma		255.9	2	2	2	1	5
616	1Dyc		2.1	3	4	4	5	3
617	1Dyc		55.1	3	4	4	5	3
618	5Dyb		6.0	3	4	3	3	5
619	1Dyc		16.5	4	4	4	5	5
620	5Dyc	5Ugb	2.7	4	4	4	4	5
621	1Ugc		2.8	3	3	4	4	2
622	1Ugc		1.6	3	3	4	4	2
623	1Dyc	1Ugc	5.3	3	4	4	5	4
624	5Dyc		1.8	4	4	4	4	5
625	5Dra		1.3	3	4	3	3	5
626	5DycE		0.4	5	5	5	5	5
627	6UgaE		2.0	5	5	5	5	5
628	1Dyc		0.7	3	4	4	5	2
629	5Dyd		0.7	5	5	5	5	5
630	1Dyc		1.1	5	5	5	5	5
631	6Dyg		5.8	5	5	5	5	5
632	6UgaE		30.0	5	5	5	5	5
633	6Ufa	6Uga	18.8	3	4	4	4	5
634	6Dbb		1.9	3	4	4	4	5
635	5DycE		0.7	5	5	5	5	5
636	5DycE		1.7	5	5	5	5	5
637	5Dyc	5Dra	4.4	4	4	4	4	5
638	6UgaE		0.4	5	5	5	5	5
639	6Uma		20.9	2	2	2	2	5
640	5Dya		13.9	3	3	2	1	5
641	1Ugd		19.6	4	4	4	5	4
642	6Ucc		15.0	3	4	3	2	5
643	6Dyg3		0.8	3	4	4	4	5
644	6Umb2		2.0	4	4	4	4	5
645	5R		2.4	5	5	5	5	5
646	5Dra1		2.2	3	3	2	1	5
647	5Dyc	5Dra	2.5	4	4	4	4	5
648	5Dyc5		3.1	5	5	5	5	5
649	5Dyc		9.3	4	4	4	4	5
650	5Dyb		3.5	3	3	3	2	5
651	5UgaR		0.4	5	5	5	5	5
652	5Uga	5Dra	1.0	3	4	4	4	5
653	5Uga	5Dra	1.2	3	4	4	4	5
654	5Uga		0.9	3	4	4	4	5
655	5Uga		1.1	3	4	4	4	5
656	5Uga		1.7	3	4	4	4	5
657	5Uga		0.9	3	4	4	4	5
658	5Dya		25.0	3	3	2	1	5
659	6Dbb	6Ugc	27.0	2	3	3	3	5
660	5Dra	5Ugb	2.9	3	4	4	4	5
661	5Uga	5Dra	2.3	3	4	4	4	5
662	5Dya		38.2	3	3	2	1	5
663	5Dya	5Uga	4.1	3	4	4	3	5
664	5Dra	5Uga	4.1	3	4	4	3	5
665	5Dyb		8.3	3	3	3	3	5
666	5Dra	5Ugb	4.4	3	4	4	4	5
667	5Dyb		3.7	3	3	3	3	5
668	5Ugb		0.7	3	4	4	4	5
669	5Dra	5Ugb	16.2	3	4	3	3	5
670	2Dyb		3.1	3	3	4	4	3
671	2DybE		1.9	5	5	5	5	5
672	5Dra		3.7	3	4	3	3	5
673	5Dyc		1.3	4	4	4	4	5
674	1Dyc		2.6	4	4	5	5	3
675	1Dyc		1.4	3	4	4	5	3
676	5Dra		3.2	3	4	3	2	5
677	5Dyc		5.3	4	4	4	4	5
678	5Dra3	5Ugb1	4.9	3	4	4	4	5
679	6Dbe		2.8	3	4	4	4	5
680	1Dyc	1Ugc	4.7	3	4	4	5	5
681	1Ugc		1.8	3	3	4	4	5
682	1Dyc		6.9	3	4	4	4	5
683	1UgcE		3.3	5	5	5	5	5
684	6Gna		5.5	3	4	4	3	5
685	5Dyc		7.8	4	4	4	4	5
686	5Dyc		1.3	4	4	4	4	5
687	5Dra		53.5	4	4	3	2	5
688	5Dra1	5R	7.9	5	5	5	5	5
689	5Dyc1	5R	6.2	5	5	5	5	5

Table 6.2.2 (continued)

UMA No.	UMA name		Area ha	Land suit. C	G	S	M	R
690	5Dra		0.8	4	4	3	1	5
691	5Dra1	5R	0.7	5	5	5	5	5
692	5Dyc		1.7	4	4	4	4	5
693	5Dyb		2.0	3	3	3	2	5
694	5Dyc		8.9	4	4	4	4	5
695	5Uga		1.1	3	4	4	4	5
696	5Dra		1.0	3	3	2	1	5
697	5Dyc		1.2	4	4	4	4	5
698	5Dyb		1.5	3	3	3	2	5
699	1Uga		1.0	3	3	4	4	5
700	1Dyc		0.5	3	4	4	5	5
701	5Dya		4.7	3	3	2	1	5
702	2DybE		15.1	5	5	5	5	5
703	2UghE		2.1	5	5	5	5	5
704	1Dyc		0.9	3	4	4	5	2
705	2Ddb		1.3	4	5	5	5	4
706	1Uga		1.0	3	3	4	4	5
707	6Uma2		17.9	2	2	2	2	5
708	6Gnd		10.2	2	2	2	1	5
709	6Gnd		1.8	2	2	2	1	5
710	2Dbc		7.2	2	3	4	4	3
711	6Gnd		15.5	2	2	2	1	5
712	6UmaE		18.9	5	5	5	5	5
713	6GndE		9.8	5	5	5	5	5
714	2Uge		1.6	2	2	4	4	2
715	5Ugb	5Dyc	4.3	4	4	4	4	5
716	5Uga		1.3	3	4	4	4	5
717	5Uga		0.2	3	4	4	4	5
718	5Uga		0.2	3	4	4	4	5
719	6Gne		2.1	2	3	2	2	5
720	6Gna		80.0	2	3	2	2	5
721	5Dyc		9.8	4	4	4	4	5
722	1Ugf		21.4	4	4	5	5	3
723	5Dya		1.0	3	3	2	1	5
724	5Uga	5Dra	6.6	3	4	4	4	5
725	6Dbb		115.2	2	3	2	2	5
726	6UmaC		75.5	4	4	3	2	5
727	6Dbb		18.2	2	3	2	2	5
728	6DbbE		9.7	5	5	5	5	5
729	6Ugc		3.0	2	3	4	4	4
730	6DbbE		3.9	5	5	5	5	5
731	5Dyc		16.4	4	4	4	4	5
732	1UgaE		3.9	5	5	5	5	5
733	1Uga		6.8	3	4	4	4	4
734	5Dra3	5Uga	7.0	4	4	4	4	5
735	5Dra		4.2	2	3	2	1	5
736	5Dra		2.0	2	3	2	1	5
737	5Uga		9.0	2	3	4	4	5
738	5Ugb		5.6	2	3	4	4	5
739	6Gna		2.5	3	4	4	3	5
740	1Uga		0.7	3	4	3	4	4
741	1Ugd		0.9	3	4	3	4	4
742	1Dyc	1Ugd	9.8	3	4	4	4	4
743	1Ugd		1.3	3	4	3	4	4
744	1Dya		1.1	4	4	4	4	4
745	5R		0.2	5	5	5	5	5
746	1DycE		4.1	5	5	5	5	5
747	1Dba		2.4	4	4	4	4	3
748	1Dba		0.8	4	4	4	4	3
749	1UgcE		2.1	5	5	5	5	5
750	6Dbb		6.7	4	4	4	4	5
751	6Ucc		10.1	3	4	2	2	5
752	6Dbf		87.7	2	2	2	2	5
753	6Dbb		2.1	4	4	4	4	5
754	6Dbb		1.9	4	4	4	4	5
755	6Dbf		3.7	3	4	2	2	5
756	6Dbb		2.7	3	4	4	4	5
757	6Dbb		1.5	3	4	3	4	5
758	1Dyc		2.1	3	4	3	4	4
759	6Gne		54.6	2	3	2	2	4
760	6Dbb		2.5	4	4	4	4	4
761	6Dyg		2.8	4	4	4	4	4
762	6GneE		9.1	5	5	5	5	5
763	6Gne		0.7	4	4	3	3	5
764	6Umb2		49.1	2	2	2	2	5
765	5Dya5		3.3	3	4	3	3	5
766	6Dbb		3.6	4	4	4	4	5
767	5R		4.4	5	5	5	5	5
768	5DraR	5UgaR	7.5	5	5	5	5	5
769	6Uma		83.4	2	3	2	2	5
770	6UmaE		14.4	5	5	5	5	5
771	6Gne		21.8	2	3	2	2	5
772	6Ucc		5.6	3	4	3	3	5
773	6UccE		4.4	5	5	5	5	5
774	6Uma		2.0	4	4	3	3	5
775	6UgaC		2.5	5	5	5	5	5
776	6Uma		5.5	4	4	3	3	5

Table 6.2.3 Areas (ha) of land suitability classes for sugar-cane, grain crops, small crops, mangoes and rice for Leichhardt Downs Section, Burdekin River Irrigation Area.

Class	Areas (ha) of land suitability classes				
	Sugar-cane	Grain crops	Small crops	Mangoes	Rice
Class 1	-	-	-	1333.0	-
Class 2	4245.9	491.8	2011.7	1043.6	2169.5
Class 3	3418.4	5134.2	743.4	578.4	1175.5
Class 4	1330.0	3276.1	5631.7	5077.4	1024.8
Class 5	656.1	748.3	1263.6	1618.0	5280.6
	Total area = 9650.4 ha				

6.3 Limitations to irrigated agriculture

The limiting factors and the soil and land attributes used to determine the subclasses of the limiting factors of the classification are discussed below.

Climate, although not a limiting factor in this classification, may also affect crop productivity and is also discussed.

Climate. High sugar-cane yields as well as high commercial cane sugar (CCS) make the Lower Burdekin Valley the highest yielding sugar district in Queensland (Ham 1985). Suitable soils, the availability of irrigation and favourable climatic variables (mainly high light intensity and temperature) are the main factors contributing to these higher yields. Although the climate of the Lower Burdekin is highly suitable for sugar production, climatic variables such as temperature, daylength, light intensity and rainfall may impose some limitations on other irrigated cropping in the study area.

Wet and dry season cropping of rice has been successful in the Burdekin. Generally, winter planted rice yields more than summer planted rice. Barnes and Reid (1978) showed a 30% difference in yield between a winter and summer planted rice crop and attributed the difference to lower sunshine levels due to cloud cover between panicle initiation and grain filling. Lodging and the presence of higher populations of nematodes in the soil during the wet season can also contribute to lower yields in summer planted crops (Shannon personal communication).

The yield of winter rice crops can be affected by low temperatures, as night temperatures less than 15 to 16°C for three consecutive nights before head emergence, can cause sterility in rice (Cox personal communication).

Generally, grain cropping in the wet season has not been widely practised due to the lack of suitable varieties. However disease resistant varieties of maize and soybeans suitable for the day length experienced are now available for the area. Generally, the incidence of disease is higher under the hot humid conditions experienced during this period.

A range of planting dates is suitable for grain cropping during the dry season. A number of climatic factors as well as crop variety selection must be considered before choosing the time of planting. For instance, frosts although rare, can damage frost-susceptible crops in some years. High night temperatures at flowering can reduce potential yields of sorghum. High temperatures at flowering and seed set can reduce the oil content of sunflowers. These factors must be considered before selecting the correct planting date in order to maximise potential yields.

Soil Depth (d). In this classification, soil depth refers to the effect on root proliferation and plant available water. The factor only considers depth to rock or pan but does not consider rooting depth restriction caused by sodicity or salinity.

Only soil types on gently undulating rises on LU 5 are affected by this limitation. Mapping units 5Uga, 5Ugb, 5Ugc, 5Dra, 5Dya, 5Dyf and occasionally 5Dyb and 5Dyc are 0.6 to 1 m deep and usually have a slight limitation.

Some mapping units of 5Dra, 5Dya and 5Dyc have been mapped as shallow variants of these soil types and have been given a subclass of 3. Dyke rocks are often associated with these mapping units. Unique map areas 505, 516, 559, 564, and 605 also have exposed dyke rocks which only occupy a small percentage of the whole UMA. Soils surrounding these dykes are shallow but the area concerned is regarded as insufficient to warrant a depth limitation subclass.

Depth to hard/slowly permeable subsoils (pb). Duplex soils with B horizons with extremely hard consistence, coarse macro-structure, especially with columnar to prismatic structure, and high ESP at shallow depths, present a number of constraints to a growing crop and the management of that soil. Rooting depth is restricted due to high bulk density and poor aeration. Permeability is reduced which lowers plant available water capacity.

Of those soils on which cropping has already been attempted in the Lower Burdekin Valley those soils with shallow A horizons (< 0.12 m) have produced the lowest yields under average management inputs. The productivity from these soils has been so low that many farmers have ceased to continue irrigated cropping on these soil types. These soils have therefore been considered as unsuitable for grain cropping. The

depth to the hard sodic B horizon (depth of A horizon) is considered as being one of the reasons for these soils being unsuitable for cropping.

Soil types 1Dya, 2Dba, 2Ddb, 2Dya and 5Dyd always have this shallow A horizon and have a subclass of 4. Soil types 1Dyb, 1Dyc and 1Dda have a wider range of A horizon depths and can have a subclass of 3 or 4.

Soils with deeper A horizons do not present as many problems as the shallow surfaced soils due mainly to the better physical nature of the upper B horizons which usually have lower ESPs. Soil types 2Dyb, 2Dbb, 2Dbe, 6Dbe, 6Dyg and 6Dyj have A horizons between 0.1 m and 0.2 m and have a subclass of 3.

Soil types with A horizons between 0.2 m and 0.4 m in depth overlying hard B horizons are regarded as having only a slight limitation to crop growth. These soil types include 2Dbc, 2Dbd, 6Dbc, 6Dbf, 6Dbb, 6Drc, 6Dyb, 6Dyf, 6Dyh and 6Ddb. Those soil types with a range of A horizon depths between 0.1 m and 0.3 m are allocated a subclass of 2 or 3 depending on the soils examined within each UMA. These soil types include 2Dyc, 4Dyg, 4Dba, 4Dyh, 5Dyc, 5Dyf, 6Dba, 6Dbh and 6Dda.

Nature of surface soils (ps). The establishment of a uniform plant stand of desired density is important for successful crop production. Germination, seedling emergence and crop establishment may be affected by adverse physical conditions of the soil surface. These conditions include hardsetting, crusting or coarse self mulching characteristics. In the BRIA commercial experience and research have demonstrated that seedling emergence and germination problems exist on the duplex soils and cracking clays of LU 2 (Smith and McShane 1981), on the cracking clays of LU 3 and duplex soils of LU 5 (McDonald unpublished report) and on the solodic-solodized solonetz of LU 1 (Elliot and McDonald 1987).

Yule et al. (1976) suggested that seedling emergence problems can be expected to be more frequent on those cracking clays with a large fraction of their dry aggregates > 5 mm. Coughlan and Loch (1984) established a relationship between percent dry aggregates > 5 mm and cation exchange capacity (CEC), exchangeable sodium percentage (ESP) and clay percentage for the 0.1 m layer using data from 26 different cracking clays from Central Queensland and the Darling Downs. The regression equation developed is:

percent dry aggregates
> 5 mm = 14.2 + 6.9 ESP + 1.15 (% clay) - 1.39 CEC.
(n=26, r^2=0.755, P<0.01).

Gardner and Coughlan (1982) suggested that the results from this equation can be used to identify cracking clays that may have emergence problems in the BRIA by comparing them with the results from soils with and without emergence problems. They quoted examples of two cracking clays on the Darling Downs with and without emergence problems which have dry aggregates > 5 mm of 48 and 22 percent respectively. Using these criteria most cracking clays in the Leichhardt Downs Section will present some problems with germination.

A soil crust has been defined by Awadhwal and Thierstein (1985) as a thin hard layer formed on the surface of a soil due to dispersive forces of rain drops or irrigation water followed by drying. The mechanical resistance offered by these crusts can impede the emergence of young seedlings even when other factors such as availability of moisture, oxygen, soil temperature and planting depth are not limiting. Northcote (1979) defines hardsetting as the condition of a dry surface soil when a compact, hard and apparently apedal condition prevails. This condition can also offer resistance to the emergence of young seedlings. In the BRIA, the hardsetting condition is present on many soils, especially on duplex soils. The development of crusts has also been observed on many soils.

Loveday (1981) stated that surface soils with high proportions of fine sand and sometimes with significant silt and with low organic matter levels present problems with seedling emergence and water infiltration. Sodicity in the surface also favours crust formation. A horizons of some duplex soil types, especially on LU 2 and LU 6A as well as 6Dbh from LU 6B, have high proportions of fine sand and are expected to present emergence problems due to crusting.

Gardner (1979) also states that crusting problems will occur on sandy loams, loams, silty loams and sandy clay loams. Many soil types in the BRIA with clay loam A horizons set hard and some of these now under irrigation present problems with emergence and establishment of crops.

Most soil types with rigid surfaces are given a subclass of 3 for ps although duplex soils with shallow A horizons (< 0.12 m) with strongly sodic B horizons may be rated as 4. The incorporation of the sodic B horizon with the A horizon is expected to create the greater emergence problem.

Fewer emergence problems are expected on soil types 6Uma, 6Umb, 6Gnd, 6Dbc, 6Dbf, 6Gne, 6Uga, and 3Ugf and these soils have a ps subclass of 2.

Distribution of soils (pd). Efficient irrigation of a crop occurs when irrigation water is stored temporarily in the soil as soil water and subsequently redistributed to the crop if drainage below the active root zone, runoff and evaporation are minimised (Yule 1986). Therefore, soil types within manageable production units, should have similiar soil water stores and infiltration attributes to maximise crop productivity. If these attributes are not present, productivity over the whole unit will be reduced by ineffective irrigation sheduling and inopportune timing for planting, cultural and harvesting operations.

The limiting factor is applied to a compound UMA or small adjoining UMAs with soils of contrasting attributes of infiltration and permeability. The attributes used to determine the subclasses are a combination of contrasting depths and textures of the A horizon as well as permeability of the B horizon. A 300 m transect is used as the basis to determine the distribution of those soil attributes as a furrow length of 300 m is regarded as the minimum length for a manageable irrigable block.

Twenty compound UMAs of 5Dra and 5Uga or 5Ugb were mapped and regarded as having a subclass of pd4 due to the markedly different permeabilities of the soil types. Also in landscape unit 5, a number of small UMAs (average size 6.1 ha) of cracking clays which adjoin UMAs of 5Dra have a subclass of 4 for the pd limitation.

Landscape unit 6B, especially south of the locally named Sheep Camp Creek in the south east is the most variable landscape unit due to the range of contrasting soils within and between UMAs. Deep sands (6Uca) in association with solodic-solodized solonetz (6Dyh, 6Dyg) and podzolic soils (6Dyb, 6Dbf) with contrasting PAWC and infiltration rates would cause problems in efficent furrow irrigation management. **This whole area is regarded as unsuitable for furrow irrigation and should be retained as a reserve. This area may be suitable for small crops or tree crops using micro irrigation techniques.**

Subclass, pd3, has been allocated to many compound UMAs of cracking clays and solodic-solodized solonetz of LUs 1 and 2 due to contrasting differences in texture or depth of A horizon.

The subclasses for the limiting factor, distribution of soils, is applied to rice in a different manner than that for other crops. The suitability of the UMA being assessed, as well as adjacent UMAs, is determined for other limiting factors before applying this factor. The pd factor is then applied depending on the suitability of the soil types within the UMA or the adjacent UMAs. The UMA is regarded as unsuitable (that is pd4) if one or more soil types within the UMA is not suitable (if UMA > 300 m in width or length) or if the adjacent UMA is not suitable (if UMA is < 300 m in width or length).

Texture of surface soils (pt). The most cost effective means of furrow irrigating is to minimise the number of water applications per crop without causing an economic yield reduction. This involves maximising the available soil water in the soil for subsequent use by the crop. However, this is difficult to achieve when furrow irrigating soils with surface textures of sand to sandy loam due to excessive internal drainage. This results in low available soil water and causes difficulties in successfully irrigating to the ends of runs especially when the furrows are long.

The costs of irrigation and the management inputs required will increase as coarse textured horizons become thicker. Soils with > 0.9 m of sand to sandy loam (deep sands, 4Ucc, 6Uca, 6Ucc) are regarded as unsuitable. Trickle or other micro irrigation methods would be more suitable on these soils as water application rates can be more easily controlled. Duplex soils with coarse textured A horizons between 0.45 m and 0.9 m have a pt subclass of 2 or 3.

Salinity (sa). The presence of salinity in the soil solution can affect crop growth by reducing the water available to the crop (osmotic effect) and by increasing the concentration of certain ions that have a toxic effect on plant metabolism (specific effect) (FAO 1985). A wide range of salt tolerances exist for various agricultural crops (Maas and Hoffman 1977). This has not been accounted for in this land suitability

classification for the BRIA. A new land suitability classification proposed by Donnollan and Day (1986) considers the specific salinity tolerances of different crops for the salinity limitation.

Only soil types 1Dya, 1Dyb, 1Dyc, 1Dda, 2Dbb, 2Dyb and 2Dya have a subclass of 3 for salinity. No soil types are unsuitable due to the salinity limitation.

The criteria only considers the salt levels of the virgin profile. Leaching of salts from the profile has not been considered nor has secondary salinisation due to rise in water tables caused by clearing, cultivation or irrigation.

Sodicity (so). High levels of sodium on the exchange complex can affect plant growth by the direct toxicity effect, by development of poor soil physical conditions and by reducing the availability of and causing imbalances between calcium and magnesium. Northcote and Skene (1972) developed three classes of sodicity based on ESP-: non sodic (< 6), sodic (6-14),and strongly sodic (> 15). The lower value of 6 is suggested by Australian experience as being associated with the onset of hardsetting characteristics, surface sealing and reduced permeability (Loveday and Bridge 1983). A value of 15 was orginally proposed by the United States Laboratory Staff (1954) above which adverse physical properties are exhibited. The ESP values of > 14 has been adopted as strongly sodic as a discrepancy between the upper level of the sodic class and the lower level of the strongly sodic class (> 15) exists in the classes of Northcote and Skene (1972).

This general land suitability classification for crops other than rice regards those soils with an ESP > 14 by 0.2-0.3 m as unsuitable. As a large proportion of the rooting system of most crops is developed in the upper 0.3 m of soil, the level of ESP is assessed at 0.2-0.3 m. In the BRIA, productivity of soil types with high ESP by a depth of 0.2 to 0.3 m is low.

Baker, Rayment and Reid (1983) developed a power function between ESP and laboratory pH using soils analysed in the survey by Reid and Baker (1984). The function is $Y = a.X^b$ where Y = ESP and X = laboratory pH. For solodic-solodized solonetz the relationship was good (r^2 =0.85, n=60, a=5.229 x 10^{-4} and b=5.016) but a poorer relationship was obtained for cracking clays (r^2=0.5, n=72, a=5.111 x 10^{-4} and b=4.583). These relationships have been used to predict the ESP in soils where little ESP information is available or where the pH of a soil type at 0.2-0.3 m has a wide range. Field pH has been used instead of laboratory pH as a strong relation usually exists between field and laboratory pH.

Those soil types with a subclass for sodicity of 4 are 1Dyb, 1Dba, 2Dba, 2Ddb, 4Dyh, 5Dyd, 6Dbh and 6Dyj. Soil types with a pH range between 6.5 and > 8.0 at 0.2-0.3 m may have a sodicity rating of 3-4. Most solodic-solodized solonetz have a sodicity rating of at least 3 except for 2Dbe, 6Drc, 6Dbe and 6Dyb. Some cracking clays have a rating of 3.

Topography (t). Gradients and lengths of furrows should be designed to meet the water application rate, the infiltration characteristics of the soil and sensitivity of the crop to waterlogging (Loveday 1981). The potential for soil erosion in the furrow must also be considered (Shaw and Yule 1978).

The optimum furrow gradients for soils of the BRIA have been regarded as 0.03 to 0.25 percent. Elliot and McDonald (1987), however, have found that < 0.1 percent furrow gradient on a solodic-solodized solonetz (1Dyc) is too low for effective furrow irrigation of maize and soybeans due to slaking and dispersion of the clods on the hills into the furrows. Irrigation on about 0.5 percent slope was regarded as too steep due to poor infiltration.

Studies in USA have shown that furrow irrigation on slopes greater than 0.7 percent causes erosion on the upper parts of fields and deposition on the lower end (Carter et al. 1985). Observations on the Gaynor Research Site on 0.5 percent slope and Leichhardt hydrology site (1 percent slope) have shown that soil movement down the furrow is occurring. However soil losses on a cracking clay in the Emerald Irrigation Area on 2 percent was only 3t/ha per irrigation in initial waterings reducing to nil during the season (Sallaway personal communication).

As more information on the slope-infiltration interactions is available for the soils of the BRIA since this suitability classification was developed, the gradients proposed in this classification, especially for solodic-solodized solonetz, have therefore been amended in a new classification proposed by Donnollan and Day (1986). Gradients greater than 1 percent for sodic duplex soils and 2 percent for other soils have been excluded from suitable lands for grain and small crops. Gradients less than 0.06 percent are regarded as too low for effective furrow irrigation.

There are few UMAs of subclass t4 (that is > 2 percent). Some small UMAs such as 247, 763 and 776 are adjacent to creeks while others such as 687, 688, 690 and 691 are on the lower slopes of Stokes Range. Soils of LUs 4 and 5 often have a subclass of 2-3. Soils of the other alluvial landforms either have a subclass of 2 or have slopes below 0.25 percent.

Flood irrigation of rice requires ponding of water to a minimum depth of 0.05 m and a maximum depth of 0.2 m (Borrell personal communication). Using this criteria, a rice bay on a slope of 0.5 percent will have a bay width of 30 m which is regarded as the minimum sized bay of manageable size. In addition, bays on slopes steeper than 0.5 percent present problems with management (Gilbert personal communication). Slopes < 0.03 percent present problems with flushing. In the suitability classification, complex or uneven slopes have been distinguished from simple slopes as these lands will require greater levelling.

Simple slopes between 0.5 and 0.75 percent are regarded as currently unsuitable as costs of levelling required to reduce the slope to an acceptable level would be unacceptably high at present rice

returns. Soil types that would otherwise be suitable for rice but may be unsuitable due to the topography limitation include 1Dya, 1Dyc, 1Dda and 1Dba.

Fertility (n). Adequate soil nutrients applied at the correct time are necessary to maximise crop yields under irrigation.

Thompson (1977), Reid and Baker (1984) and Maltby and McShane (1988) have shown that soils in the BRIA are generally low in fertility, and nitrogen, phosphorus and often potassium will have to be applied. Maltby and McShane (1988) has also shown from pot experimentation that sulphur is deficient over large areas of the right bank of the BRIA. However this needs confirmation with field studies. Mikkelsen and Kuo (1976) have shown than zinc deficiencies are common in soils with pH of 7.4 or higher. A number of solodic-solodized solonetz and some cracking clays especially after levelling will therefore require zinc applications due to exposure of alkaline subsoils.

For most soils, the application of nitrogen and phosphorus and often potassium will be part of normal farming practice to replace those elements removed by the crop, losses through leaching, runoff and into the atmosphere. However some soils, deficient in nutrients in the virgin state, will require large applications of elements initially to compensate for fixation into unavailable forms as well as into the available forms required for plant growth. Those soils with a number of deficient elements will also require inputs greater than for those soils with fewer elements to correct for deficiency. These initial additional requirements for fertiliser is the basis of the classifiction.

The subclasses of the classification for the fertility limitation are based on the ratings of Bruce and Rayment (1982) for the level of the major nutrients in the analysed soil profiles as well as other appropriate analyses from the district. Those soil types with very low levels for one or two major nutrients have a subclass of two while those with more than two nutrients with very low levels have a subclass of three. The classification does not rate a soil as unsuitable on the fertility limitation as the lowest subclass for fertility is n3. The classification merely indicates that the cost of fertilisers will be greater for some soils than for others.

Rockiness and stoniness (r). Rockiness refers to rock outcrop that is continuous with underlying rock. Stoniness refers to coarse fragments of rock usually cobble, stone or boulders. Rocks and stones on the surface or in the cultivation zone may interfere with cultural and harvesting operations and may damage machinery. Crops such as soybeans, sugar-cane and beans are harvested close to the soil surface to reduce yield losses so therefore the amounts of rocks or stone on the surface is more critical than for other crops. The amount of stone on the surface will determine the cost of stone picking and therefore, the requirment for stone picking is used as the subclass limits.

All UMAs with a rocky phase are given a suitability subclass of 4 or 5. Some UMAs of LUs 4 and 5 have a subclass for rockiness and stoniness of 2-3. Unique map areas 102, 509, 510, 593, 616, 617, 381

and 46 of LU 1 also need stone picking (r2-3). Some UMAs including 594 and 630 of LU 1 and 48, 104, 210, 390, 391, 415, 506, 597, 609, 629 and 678 of LU 5 have subclasses of 4. The abundant rock outcrop or surface stone of these UMAs is associated with dyke rocks which will create problems with removal.

Microrelief (g). Even surfaces with sufficient gradient to allow water to run from the source of supply to the end of the run are required for furrow irrigation. Therefore areas with gilgai or other microrelief must be levelled to ensure that furrow irrigation is possible.

Assessment of this limitation is based on the vertical interval of the microrelief. The amount of levelling, and therefore the cost, will increase as the vertical interval increases. After irrigation, filled areas are likely to settle to varying degrees and will necessitate relevelling to eliminate low spots and waterlogging (Loveday 1981).

Other problems associated with levelling of gilgais include uneven crop stands and therefore lower productivity due to exposure of subsoils often with higher pH, higher ESP, lower organic matter and various nutrient imbalances. These problems usually increase as the vertical interval increases due to the exposure of the B horizon from lower depths.

Most cracking clays have a subclass of g2 or g3. Some UMAs, such as 750, 753, 754 and 726 have a subclass of 4 due to the vertical interval (> 0.6 m) of the stabilised overflow channels on the levee of the Burdekin River.

Wetness (w). Wetness refers to excessive water on the soil surface and in the profile, as a result of rainfall or local run-on water. The excess water is caused by inadequate surface drainage and poor soil permeability. The limitation refers to the additional engineering works that may be required on some lands before normal preparation procedures for furrow irrigation can be undertaken. Levelling involving both cut and fill and surface drainage may be necessary.

A subclass of 5 may be allocated to those lands which are wet for most of the year and are uneconomical to reclaim. Swamps and lagoons are examples. Land with a subclass of 4 are low lying natural drainage areas and include UMAs 25,26 and 235. UMAs 641, 648 and 722 are drainage areas lower in the landscape than the Burdekin levee backplain and the gently undulating rises. A large farm dam which leaks, has been constructed across a creek which terminates in UMA 439 (3Ugd) on the alluvial plain. When water is retained in the dam, a constant flow of water empties onto UMA 439.

When the irrigation scheme is implemented, the drainage design may alleviate the problem of wetness in many of these UMAs.

Erosion (e). Erosion of the area can be divided into 2 categories:
(i) sheet and rill erosion of the sloping lands of LUs 1, 4 and 5.
(ii) stream bank erosion of Cassidy, One Mile and Stokes Creeks.

(i) Sheet and rill erosion. The erodibility of a soil or its susceptibility to erosion depends on a complex interaction of a number of its physical and chemical factors. Particle size, percent organic matter and structure of the A horizon, and permeability of the profile are used in the Universal Soil Loss equation to determine erodibility (Wischmeier and Smith 1978). Those soils with a shallow, massively structured A horizon of medium texture together with an impermeable B horizon are the most erodible. The length and degree of slope also substantially affects the rate of soil erosion by water. The amount, frequency and intensity of rainfall are important parameters influencing the erosive energy of rain. The potential erosion during the summer months is high because 77% of the average annual rainfall falls during the months of December - March and as the one in ten year 30-minute rainfall intensity for Ayr of 125 mm per hour (Burdekin Project Comittee 1977) is expected to be similar to that of the survey area.

Much of LU 1 has slopes between 0.5 and 1% with the majority of the duplex soils in this slope category. Soil types 1Dya, 1Dyc and 1Dda which have clay loam A horizons with impermeable B horizons are found on long, low slopes and are therefore very susceptible to erosion. In addition, these soils have strongly sodic B horizons which are highly dispersible. Cover crops should be grown during fallow periods, especially over the wet season, to reduce soil losses on these soils.

Soils of LU 5, especially those on the upper and midslopes, have slopes between 1 and 2%. Although these soil types, 5Dra, 5Dya and 5Dyb, are less erodible than the solodic-solodized solonetz, soil losses on unprotected land will be unacceptable due to the greater slopes. Graded banks as well as short runs and stubble mulching techniques will be needed for protection against soil erosion.

(ii) Stream bank erosion. Stream bank erosion is severe along Cassidy and One Mile Creek and to a lesser extent on Stokes Creek. UMAs 728, 730, 732 and 770 are also severely eroded on an unnamed Creek flowing into the Burdekin River. All UMAs with an eroded phase (E) have a subclass of e5. These areas will need to be stabilised to avoid further progression of gullies.

Flooding (f). As discussed in section 2.3.1 the areas likely to be inundated by floods will change with irrigation development. The subclasses used in the suitability classification are based on the return periods for local flooding. These return periods are difficult to estimate but have been applied to susceptible areas based largely on local knowledge. These ratings may also change with the construction of drainage works for the irrigation scheme.

Intake or recharge attributes (i). Under stable climatic conditions natural landscape systems come to a hydrological equilibrium with outflows from the system in equilibrium with inflows from rainfall (Shaw et al. 1986). Often this system is in a fine state of balance and any alterations to the system may affect the equilibrium.

Recharge or intake areas which have been defined as that portion of the landscape where the net saturated flow of ground water is directed away from the water table (Shaw et al. 1986) have been identified in the BRIA. This limitation considers the effects of increased water input via irrigation into these recharge areas. The process is described in section 2.3.2.

The subclasses for the limitation are based on the management inputs required on these intake areas to decrease the affects of off-site seepage and salinisation. UMAs of 5Dra and 5Dya are rated as 3 for this limitation. **Sprinkler irrigation or other low volume irrigation methods are recommended on these soils as salinisation and seepage is expected down slope if these soils are furrow irrigated.**

Soils such as uniform coarse sands of LUs 4 and 6 (4Ucc, 6Uca and 6Ucc) have even higher hydraulic conductivities than 5Dra and 5Dya and are expected to cause greater off-site seepage and salinisation problems if furrow irrigated. Trickle irrigation of tree crops is recommended on these soils.

Outflow or discharge attributes (o). Outflow or discharge areas are those portions of the landscape where the net saturated flow of groundwater is directed towards the watertable (Shaw et al. 1986). In a discharge area there is an upward component to groundwater flow near the soil surface which may result in salinisation. This process has been described in section 2.3.2.

The likely position of some potential discharge areas in the BRIA can now be identified. This knowledge is used in the classification to identify those areas which may become salinised and are therefore unsuitable.

UMAs with soil types 5Dyc and 5Dyd are potential discharge areas. Other UMAs also have the potential to become salinised depending on their postion in the landscape. The soil types of those UMAs include 1Dba, 1Dda, 1Dya, 1Dyc, 4Dyh and 5Dyb.

Profile permeability (p) (Applies only to rice). Rice produces the highest yields under flood irrigation as the crop is very sensitive to moisture stresses. Therefore rice is usually grown in ponded bays.

To maintain an adequate ponded depth of water in bays without excessive losses to deep drainage, soils with very low hydraulic conductivities in the B horizon are the most suitable for rice growing. As hydraulic conductivities have not been measured on many soils of the BRIA, subjective methods were used to rate the soils on their deep drainage losses. Morphological and other characteristics of the soil types that are known to relate to drainage within the profile were used to determine the subclasses in the classification. These characteristics are texture throughout the profile, consistence of B horizon, depth of A horizon and pH trends (or ESP). Duplex soils with A horizons < 0.2 m with extremely hard upper B horizons and textures of clay from the base of the A horizon to > 1.5 m and strongly alkaline by 0.6 m are considered the least permeable. Soils with acid or neutral

soil reaction trends or with textures coarser than sandy clay between 0.4 and 1.5 m are regarded as unsuitable (p5) due to expected unacceptable losses to deep drainage.

Most solodic-solodized solonetz and cracking clays of LUs 1, 2 and 3 have a subclass of 1-3 for this limitation.

6.4 Guidelines for irrigation development

Long term stability of land resources and sustained economic crop production are important factors to consider in the resubdivision and farm design stage of irrigation development. Measures to decrease the effects of potential degradation must be implemented. The distribution of soils and the suitability of land on individual farms must also be considered during subdivisional planning to ensure farms are economically viable.

6.4.1 Potential degradation considerations.

Degradation hazards of concern on Leichhardt Downs Section include:

- Salinisation
- Erosion
- Flooding.

These degradation hazards have been discussed in Sections 2.3 and 6.3. Developmental guidelines to reduce the effects of these hazards have been summarised in Part A (Donnollan et al. 1986) and are as follows:

*Salinisation

- Leakage from channels must be kept to an acceptable level to avoid deep drainage losses with subsequent rises in groundwater. Particular attention must be given to those parts of channels which are located in intake areas of LUs 4 and 5 and prior stream areas of LU 6.

- Discharge areas are potential areas of secondary salinisation and should be excluded from irrigable areas of farms.

- Provision must be made for the location of intercept drains immediately upslope of expected discharge areas; for example, on soil types 5Dyc or on lower slopes of LU 1 at the interface with LU 3.

- Farm boundaries should coincide with slope concavities or drainage ways wherever practical, as these areas are most at risk from rising groundwaters.

*Erosion

- Creeks and major drainage depressions must be protected by adequate buffer zones and should be retained as drainage reserves and be adequately maintained.

. Any land, outside a reserve, which is degraded by gully erosion must be rehabilitated before inclusion within farms. Gullies must be filled with suitable soil, compacted, allowed to consolidate, and then be levelled.

. Within reserves, existing gullies migrating from creeks and drainage depressions, must be stabilised to prevent further progression.

. Adequate provision must be made for sufficient land on farms, additional to the irrigable area, to accomodate internal farm roads, supply channels, drains and necessary erosion control works.

* Flooding

. The drainage system of the developed area must be designed so that depth and length of inundation is minimised to reduce crop damage or loss.

. Roads, tramlines,water supply channels and drains must be located so that natural drainage is not impeded.

6.4.2 Farm subdivisional considerations

The suitability of the soils and the complexity of the land in terms of soils and relief characteristics must be considered before subdividing land into farms. Some aspects of these considerations have been discussed in Section 6.3 but the major considerations are summarised below.

* Complex soil distribution and relief.

. Areas with dyke rocks exposed on the surface, associated with complex patterns of soils or salinisation hazard, should be excluded from irrigable areas of farms.

. Where possible, large contiguous areas with complex patterns of managerially different soils and which, with irrigation development, may adversely affect suitable lands downslope, should be excluded from farm design and set aside as reserves.

. The subdivision of areas with variable topographical relief must be considered carefully so that major land levelling is not required to obtain suitable production areas at the farm level. This is most important in areas of solodic-solodized solonetz. Levelling of these soils may expose subsoil which will reduce production from these areas.

* Land suitability classes

. All lands of classes 4 and 5 should be excluded from irrigable areas of farms.

- Farm boundaries within areas of suitable land (that is, classes 1, 2 and 3) should be located so that soils with similar management requirements can be grouped into relatively large areas.

- Although the area is being subdivided on the basis of suitabilityfor sugar-cane, the land suitability for other crops must be considered before subdivision is effected. Sugar-cane assignments may not be available in the short term.

6.5 Farm management

Suitable on-farm management strategies are needed to ensure sustained economic crop production and assist in resource stability. Table 6.5.1 presents the land suitability classes of the agricultural management units (AMUs)* and summarises their soil and land limitations as well as their management considerations.

Many agricultural management units have similar management problems, especially those with soils with similar morphological attributes. For the Leichhardt Downs Section, AMUs of cracking clays and solodic-solodized solonetz are the most widespread, occupying 36 and 32 percent of the area respectively. Although the options to alleviate these management problems may vary between AMUs of these cracking clays and solodic-solodized solonetz, the general principles for the whole groups are similar. The following discussion outlines some of the problems and possible solutions to these problems for cracking clays and solodic-solodized solonetz.

6.5.1 Management problems of cracking clays

Cracking clays are favourable soils for irrigation but suitable management strategies are needed to ensure that irrigation of these soils is successful. Some of the more important problems associated with the irrigation of cracking clays include:

a) Reduced permeability in the swollen state so that both infiltration and internal drainage are very slow.

b) Narrow optimum moisture range for tillage and seedling operations.

c) Germination and emergence difficulties associated with rapid drying of granular surfaces and sealing or crusting of some types.

d) An uneven land surface requiring levelling (especially where gilgaied), and gradients requiring adjustment for efficient irrigation.

* See glossary

Table 6.5.1 Land suitability classes, soil and land limitations and management considerations for agicultural management units, Leichhardt Downs Section, Burdekin River Irrigation Area.

Agricultural management units	Land suitability classes					Soil and land limitations		Management considerations
	Sugar cane	Grain crops	Small crops	Mangoes	Rice	Physical	Chemical*	
1Uga, 1Ugc, 1Ugd, 1Ugf	2	3	4	4	2-3	Gilgai to 0.30 m Waterlogging Flooding in some areas	Low general fertility with very low phosphorus levels Often strongly alkaline by 0.30 m Sodic to strongly sodic below 0.50 m Medium to high salt levels at 0.50 - 0.90 m.	Seedling emergence Wet season land preparation and harvesting Precision levelling required for adequate surface drainage Narrow range of optimum moisture for tillage operations. Uneven crop stand due to soil variability after levelling.
1Uge	3	3	4	4	5	Soil variability Linear gilgai Large pebbles and cobbles on surface of mounds Slope > 1% Susceptible to erosion	Low general fertility with very low phosphorus levels Mound often strongly alkaline by 0.30 m Strongly sodic at and below 0.50 - 0.60 m Medium to high salt levels at 0.50 - 0.90 m.	Seedling emergence Erosion control practices required Irrigatin furrows may have to be positioned across the slope to decrease slope gradient Stone picking may be required in some areas for ease of tillage operations and harvesting of crops close to the soil surface. Uneven crop stand due to soil variability
1Dya, 1Dyc 1Dda, 1Dba	3	4	4	5	2-4	Shallow A horizon Surface crusting B horizon of very low permeability Low PAWC** Soil variability Slope >0.5% in some areas Susceptible to erosion	Low general fertility with very low phosphorus levels Often strongly alkaline by 0.30 m Strongly sodic at and below 0.20 - 0.30 m High to very high salt levels at 0.50 - 0.60 m (Note,1Dda may have only medium to high levels)	Seedling emergence Soil profile amendment required to increase PAWC for crops otherthan rice Fertility problems associated with exposure of B horizon on levelling Uneven crop stand due to soil variability Irrigation furrows may have to be positioned across the slope to decrease slope gradient on higher slopes Dispersive B horizons Erosion control measures required on higher slopes High management inputs required.

Table 6.5.1 (Continued)

Agricultural management units	Land suitabilities classes					Soil and land limitations		Management considerations
	Sugar cane	Grain crops	Small crops	Mangoes	Rice	Physical	Chemical*	
1Dyb	3	4	4	5	5	Shallow A horizon Surface crusting Soil variability Slope >0.5% in some areas Susceptible to erosion D horizons coarser than light clay below 0.40 - 0.60 m Low PAWC	Low general fertility with very low phosphorus levels Often strongly alkaline at 0.30 m Strongly sodic at and below 0.20 - 0.30 m Very high salt levels at 0.80 - 0.90 m	Seedling emergence Fertility problems associated with exposure of B horizon on levelling Uneven crop stand due to soil variability Unsuitable for rice growing due to rapid internal drainage below 0.40 - 0.60 m Irrigation furrows may have to be positioned across the slope to decrease slope gradient on higher slope Dispersive B horizon Erosion control measures required on higher slopes High management inputs required.
2Uga, 2Ugb	2	3	4	4	2	Low lying areas with low gradients Flooding	Low general fertility with very low phosphorus levels Sodic at and below 0.50 - 0.60 m. Low to medium salt levels at 0.80 - 0.90 m	Seedling emergence Precision levelling required for adequate surface drainage Wet season land preparation and harvesting Narrow range of optimum moisture for tillage operations.
2Ugc, 2Ugd, 2Uge	2	3	4	4	2	Low lying areas with low gradients Waterlogging Gilgai to 0.30 m Flooding Surface crusting	Low general fertility Sodic at 0.50 - 0.60 m and usually strongly sodic by 1.10 - 1.20 m Medium salt levels at 0.80 - 0.90 m	Seedling emergence Precision levelling required for adequate surface drainage Wet season land preparation and harvesting Narrow range of optimum moisture for tillage operations Uneven crop stand due to soil variability after levelling.
2Ugg	2	3	4	4	2	Low lying areas with low gradients Waterlogging Gilgai to 0.30 m Flooding	Low general fertility with very low phosphorus levels Sodic at and below 0.50 - 0.60 m Medium salt levels at 0.80 - 1.10 m	Seedling emergence Precision levelling required for adequate surface drainage Wet season land preparation and harvesting Narrow range of optimum moisture for tillage operations.

Table 6.5.1 (Continued)

Agricultural management units	Land suitability classes					Soil and land limitations		Management considerations
	Sugar cane	Grain crops	Small crops	Mangoes	Rice	Physical	Chemical*	
ZUgh	2	3	4	4	2	Low lying areas with low gradients Waterlogging Gilgai to 0.30 m Flooding	Low general fertility with very low phosphorus levels Strongly alkaline by 0.30 m Sodic by 0.50 - 0.60 m and strongly sodic at and below 1.10 - 1.20 m Medium to high salt levels at 0.80 - 0.90 m.	Seedling emergence Fertility problems associated with exposure of strongly alkaline B horizons of mound after levelling Uneven crop stand due to levelling Precision levelling required for adequate surface drainage Wet season land preparation and harvesting Narrow range of optimum moisture for tillage operations.
ZDyc	2	3	5	4	2	Low lying areas with low gradients Waterlogging Gilgai to 0.30 m Flooding Surface crusting	Low general fertility with very low phosphorus levels Sodic by 0.50 - 0.60 m and strongly sodic by 1.10 - 1.20 m Medium salt levels at 0.80 - 0.90 m	Seedling emergence Precision levelling required for adequate surface drainage Wet season land preparation and harvesting Uneven crop stand due to soil variability after levelling.
ZDba, ZDdb	4	5	5	5	2	Shallow A horizon Surface crusting B horizon of very low Permeability Low PAWC*	Low general fertility with very low phosphorus levels Strongly alkaline by 0.30 m Strongly sodic at and below 0.20 - 0.30 m High salt levels at 0.50 - 0.60 m	Seedling emergence Soil profile amendment required to increase PAWC for crops other than rice Exposure of strongly sodic B horizon on levelling and cultivation Dispersive B horizons High management inputs required.
ZDya	3	4	5	4	2	Shallow A horizon Surface crusting B horizon of very low permeability Low PAWC	Low general fertility with very low phosphorus levels Strongly sodic at and below 0.20 - 0.30 m High salt levels at 0.80 - 0.90 m	Seedling emergence Soil profile amendment required to increase PAWC for crops other than rice Exposure of strongly sodic B horizon on levelling and cultivaion Uneven crop stand due to levelling Dispersive B horizons High management inputs required.

Table 6.5.1 (Continued)

Agricultural management units	Land suitability classes					Soil and Land Limitations		Management considerations
	Sugar cane	Grain crops	Small crops	Mangoes	Rice	Physical	Chemical*	
2Dyb, 2Dbb, 2Dbe	2	3	4	4	2-3	Surface crusting B horizon of very low permeability Low PAWC Flooding in some areas	Low general fertility with low to very low phosphorus levels Strongly sodic at and below 0.20 - 0.50 m (except for 2Dbe) Medium to very high salt levels at 0.50 - 0.60 m (Dbe has only low salt levels)	Seedling emergence Soil profile amendment required to increase PAWC for crops other than rice Strongly sodic B horizon may be exposed on levelling and cultivation Dispersive B horizon Erosion control measures required in some areas.
2Dbc, 2Dbd	2	3	3	3	2-3	Surface crusting Flooding	Low general fertility with very low phosphorus levels May be strongly sodic at and below 0.50 - 0.60 m Low to high salt levels at 0.80 - 0.90 m	Seedling emergence Wet season land preparation and harvesting Erosion control measures required in some areas.
3Uga, 3Uga8, 3Ugd, 3Uge, 3Ugk	2	3	4	4	2	Low lying areas with low gradients Waterlogging Flooding Gilgai to 0.30 m	Low general fertility with low to very low phosphorus levels Strongly alkaline at 0.30 m in some areas (3Uga, 3Uga8, 3Ugk) Sodic by 0.90 - 1.20 m Low to medium salt levels at 1.10 - 1.20 m.	Seedling emergence Precision levelling required for adequate surface drainage Wet season land preparation and harvesting Narrow range of optimum moisture for tillage operations Susceptible to secondary salinisation on edge of plains.
3Ugf	2	3	3	4	2	Low lying areas with low gradients Flooding	Strongly sodic at and below 0.80 - 0.90 m May have very high salt levels at 0.80 - 0.90 m.	Precision levelling required for adequate surface drainage Wet season land preparation and harvesting Narrow range of optimum moisture for tillage operations.
4UccR	4	4	4	3	4	Surface crusting Large pebbles and cobble throughout profile Low PAWC Soil variability Slopes >1% Susceptible to erosion	Low general fertility with very low phosphorus levels.	Seedling emergence Erosion control measures required Flood irrigation unsuitable, spray or trickle irrigation recommended Downslope seepage may occur if excessive intake occurs upslope on these soils Stone picking required

Table 6.5.1 (Continued)

Agricultural management units	Land suitability classes					Soil and land limitations		Management considerations
	Sugar cane	Grain crops	Small crops	Mangoes	Rice	Physical	Chemical*	
4Dyg, 4Dyh, 4Dba	4	4	4	4	5	Surface crusting B horizon of very low permeability Low PAWC Slopes usually >1% Susceptible to erosion	Low general fertility with very low phosphorus levels Strongly sodic at and below 0.30 - 0.60 m Medium to high salt levels at 0.50 - 0.60 m.	Seedling emergence Soil profile amendment required to increase PAWC Uneven crop stand due to soil variability Susceptible to secondary salinisation in some areas Erosion control measures required.
5Dra, 5Dya	3	3	2	1	5	Surface crusting Slopes >1% Susceptible to erosion Soil depth <1m Surface stone in some areas Permeable subsoils	Low general fertility with low to very low phosphorus levels.	Seedling emergence Spray or trickle irrigation recommended to decrease deep drainage losses and prevent secondary salinisaion down slope Erosion control practices required Stone picking required in some areas for ease of tillage operations and harvesting of crops close to surface
5Dyb	3	3	3	2	5	Surface crusting Slopes >1% Susceptible to erosion Surface stone in some areas	Low general fertility with low phosphorus levels Sodic at and below 0.80 - 0.90 m.	Seedling emergence Erosion control practices required Non-saline seeps may develop if deep drainage losses are not prevented upslope Stone picking required in some areas.
5Dyc, 5Dyd	4	4	4	4	5	Surface crusting Susceptible to erosion B horizon of very low permeability Low PAWC	Low general fertility with low to very low phosphorus levels Strongly sodic at and below 0.20 - 0.50 m High to very high salt levels at 0.50 - 0.60 m	Seedling emergence Susceptible to secondary salinisation Soil profile amendment required to increase PAWC Erosion control practices required.
5Dga, 5Dgb	2	3	4	4	5	Slopes in some areas >1% Susceptible to erosion on higher slopes Soil depth <1 m Soil variability, small areas often associated with 5Dra Surface stone in some areas	Low general fertility with low phosphorus levels.	Seedling emergence Erosion control practices required on higher slopes Small areas are often closely associated with soils of different management requirements. Stone picking required in some areas for ease of tillage operations and harvesting of crops close to the surface.

Table 6.5.1 (Continued)

Agricultural management units	Land suitability classes: Sugar cane	Grain crops	Small crops	Mangoes	Rice	Soil and land limitations: Physical	Chemical*	Management considerations
5Dyf-5Ugc	3	3	4	4	5	Soil variability Surface crusting Slopes often >1% B horizon of very low permeability Low PAWC of 5Dyf	Low general fertility with very low phosphorus levels Strongly sodic at and below 0.50 - 0.60 m Very high salt levels at 0.50 - 0.60 m	Seedling emergence Different soils within complex have different management requirements Erosion control practices required on higher slopes Profile amendment may be required to increase PAWC of 5Dyf.
6Ucc	3	4	3	2	5	Soil variability Low PAWC High infiltration rates Uneven slopes in some areas Flooding	Low general fertility with very low phosphorus levels.	Seedling emergence Frequent irrigation required, sprinkler or trickle irrigation recommended Erosion control measures required in some areas.
6Uma, 6Umb, 6Gnd, 6Dbc, 6Dbf	2	2	2	2	5	Surface crusting Irregular slopes in some areas		Seedling emergence Fairly frequent irrigations required.
6Gna, 6Gne	2	3	2	2	5	Surface crusting Low PAWC Slopes >0.5% in some areas		Seedling emergence Fairly frequent irrigations required Precision levelling required in some areas.
6Dbb, 6Dba	2	3	3	3	4	Surface crusting Slopes >0.5% in some areas Soil variability in some areas	Sodic at and below 0.50 - 0.60 m.	Seedling emergence Profile amendment may be required to increase PAWC in B horizon.
6Ugc	2	3	4	4	4	Waterlogging Flooding		Seedling emergence Wet season land preparation and harvesting Narrow range of optimum moisture for tillage operations.

Table 6.5.1 (Continued)

Agricultural management units	Land suitability classes					Soil and land limitations		Management considerations
	Sugar cane	Grain crops	Small crops	Mangoes	Rice	Physical	Chemical*	
6Uca	4	5	4	3	5	Soil variability Very low PAWC High infiltration rates	Low general fertility with very low phosphorus levels.	Seedling emergence Long narrow mapping units closely associated with soils of widely different management requirements Frequent irrigations required, sprinkler or trickle irrigation recommended Intake areas.
6Uga	3	4	4	4	5	Soil variability Irregular slopes Flooding Susceptible to erosive flooding		Wet season land preparation and harvesting Erosion control measures required Uneven crop stand due to soil variability Wet season flooding.
6Ufa, 6Ufd, 6Ufe	5	5	5	3	5	Flooding Soil variability Susceptible to erosive flooding Irregular slopes		Frequent wet season flooding Wet season land preparation and harvesting Range of soils within units have different management requirements Erosion control measures required Uneven crop stand due to soil variability.
6Drc	2	3	3	2	4	Surface crusting Low PAWC Soil variability	Low general fertility with low phosphorus levels May be sodic at and below 0.90 - 1.20 m	Seedling emergence Some units closely associated with soils of different management requirements.
6Dbe	2	3	3	3	5	Surface crusting Low PAWC Flooding		Seedling emergence Wet season land preparation and harvesting Erosion control measures required.

Table 6.5.1 (Continued)

Agricultural management units	Land suitability classes: Sugar cane	Grain crops	Small crops	Mangoes	Rice	Soil and land limitations: Physical	Chemical*	Management considerations
6Dbh	4	4	4	4	5	Surface crusting B horizon of very low permeability Low PAWC	Low general fertility with low phosphorus levels Strongly sodic at and below 0.20 - 0.30 m High salt levels at 0.50 - 0.60 m	Seedling emergence Profile amendment required to increase PAWC Exposure of strongly sodic B horizon on levelling and cultivation Dispersive B horizons.
6Dyb, 6Dye,	3	4	4	3	5	Soil variability Low PAWC in A horizon	Low general fertility Medium salt levels by 0.90 - 1.20 m.	Seedling emergence Soils within units have different management requirements Uneven crop stand due to soil variability.
6Dyf	3	4	3	3	5	Soil variability Surface crusting Upper B horizon of low permeability	Low general fertility with very low phosphorus levels.	Seedling emergence Uneven crop stand due to soil variability.
6Dyh, 6Dyg	3	4	4	4	5	Soil variability Surface crusting Upper B horizons of low permeability Low PAWC	Low general fertility May be strongly sodic at 0.20 - 0.30 m.	Seedling emergence Small areas closely associated with soils of widely different management requirements Strongly sodic B horizons may be exposed on levelling and cultivation Uneven crop stand due to soil variability.
6Dyj	4	4	4	4	5	Soil variability Flooding Low PAWC Susceptible to erosive flooding Surface crusting	Low general fertility with very low phosphorus levels Strongly sodic by 0.20 - 0.30 m High salt levels at 0.50 - 0.60 m.	Seedling emergence Soils within units have different management requirements Exposure of strongly sodic B horizons on levelling and cultivation Uneven crop stand due to soil variability.

Table 6.5.1 (Continued)

Agricultural management units	Land suitability classes					Soil and land limitations		Management considerations
	Sugar cane	Grain crops	Small crops	Mangoes	Rice	Physical	Chemical*	
6Dda, 6Ddb	3	4	3	3	5	Soil variability Surface crusting	Low general fertility with very low phosphorus levels May be strongly sodic at and below 0.50 - 0.60 m High salt levels at 0.80 - 0.90 m.	Seedling emergence Small areas often closely associated with soils of widely different management requirements Uneven crop stand due to soil variability. Erosion control measures required in some areas.

* Soil salinity rating from predicted ECse values after Shaw et al. (1986).
Sodicity ratings after Northcote and Skene (1972). Other ratings after Bruce and Rayment (1982).

** Plant available water capacity.

Reduced permeability in the swollen state. Shaw and Yule (1978) showed that about 74 percent of the water applied in five hours to a cracking clay in the cracked state entered within 30 minutes. Long irrigation duration times therefore are not justified for cracking clays. The most efficient water application to cracking clays occurs when large cracks are present and water can be added quickly without erosion. These criteria need to be compromised between large cracks and plant water stress and fast application and soil erosion (Shaw and Yule 1978).

Shaw and Yule (1978) also state that irrigation should be applied when accumulated evapotranspiration is 60 to 80 percent of the plant available water. Using 75 percent of PAWC as the deficit, Gardner and Coughlan (1982) showed that irrigation should be applied at 12 to 14 day intervals to replenish a PAWC of 10 to 12 cm. This is the average PAWC for the cracking clays in the BRIA.

Observations during the field survey indicate that soil types 3Uga, 3Ugd, 3Uge and 5Uga have large cracks and crack extensively when dry. Those soil types with smaller cracks as well as a lower density of cracking include 1Ugc, 1Uge, 1Ugf, 2Ugc, 2Ugd, 2Uge, 3Ugf, 5Ugb, 5Ugc, 5Ugd and 6Uga. Much of the soil water deficit of the latter group may not be replenished before the cracks close. For maximum production, the duration of each irrigation or the number of irrigations over the crop cycle may have to be increased to compensate for the reduced amount of water entering the profile. Soil types 1Uga, 1Ugd, 2Uga, 2Ugg and 2Ugh and 3Ugk have cracking characteristics intermediate between the two mentioned groups so the duration or the number of irrigations required for maximum crop production may also be different for this group.

Satisfactory aeration of the root zone may also be affected by the very slow infiltration and internal drainage rate of the cracking clays. Hodgson and Chan (1982) showed that by increasing the inundation period from 4 to 16 hours on a grey cracking clay, cotton lint yields were reduced by 8 percent. The crops expected to be grown in the survey area except sugar-cane, soybeans and sorghum have similar tolerances to waterlogging as cotton (Landon 1984). Therefore waterlogging must be kept to a minimum on cracking clays. Accurate land levelling and suitable hilling of the furrows will be required to reduce the incidence of this problem.

The low lying position of the cracking clays as well as their poor drainage characteristics affect access and trafficability, especially during the wet season. Careful planning of operations during the wet season is needed to decrease the incidence of these problems.

Narrow moisture range. The most suitable water content for tillage of cracking clays is in the moist range between the plastic limit and the shrinkage limit (Loveday 1981). In this state, a soil should have friable consistency, low resistance to tillage tools, high ability to carry traffic, low adhesion, moderate resistance to compaction and high resistance to smearing (Archer 1975). However all these conditions are difficult to achieve in a cracking clay so suitable management skills to

know the opportune time for planting and cultural operations are required to avoid damaging soil structure or cause compaction.

As two grain crops per year will be required to be grown on these irrigation farms for profitability (Sedgwick personal communication), some difficulties will occur in selecting the opportune times for cultural operations, especially during the wet season.

Germination and emergence. Most cracking clays in the Leichhardt Downs Section will present some problems with seed germination and seedling emergence due to the relative coarseness of the surface aggregates. Surface sealing and permeability are affected adversely by ESP values of about 6 in the planting zone (Loveday and Bridge 1983). From analyses of soil profiles, the ESP levels at 0-0.1 m for the cracking clays of LUs 1, 2, 3 and 5 are lower than 4 percent. However at 0.3 m, the ESP of 1Ugf and 5Ugc approach 10 percent. As clays 1Ugf and 5Ugc will require levelling before furrow irrigation, surfaces with ESP levels that cause problems with seedling emergence may be exposed. Gypsum may then be needed to ameliorate these surfaces.

Normally, the problems of seedling emergence in cracking clays may be overcome by planting into dry soil and then irrigating. This method of planting, termed post-plant irrigation by Smith and McShane (1981), is regarded as more successful in tropical regions than pre-plant irrigation techniques especially on coarse structured or structurally unstable soils due to better soil moisture-seed contact.

The use of narrow tines and appropriate press wheels may increase seedling emergence in pre-plant situations. Water injected with the seed may also prove useful for achieving satisfactory emergence.

Levelling. All cracking clays are gilgaied except 5Uga (in most situations) and will require levelling to enable furrow irrigation techniques to be used. The vertical and horizontal interval of the gilgai will determine how much cut from the mound is required to fill the depression. Generally, problems with plant growth will become greater as the cut gets deeper and exposes subsoil with adverse chemical and physical properties. UMAs especially of 1Uga, 1Ugc, 1Ugd, 1Uge, 1Ugf, 2Uge, 2Ugh and 3Uga, may require applications of zinc and additional inputs of macronutrients when subsoils with pH > 7.5 are exposed.

Laser levelling should be undertaken, especially on clays of LUs 2 and 3, to ensure adequate surface drainage and to avoid waterlogging.

6.5.2 Management problems of solodic-solodized solonetz

Generally, the solodic-solodized solonetz in this survey have been divided into soil types on the basis of landscape unit, depth of A horizon and pH of the B horizon. As the B horizons of these soils have very low permeabilities, rice is the most suitable crop for these soils. Soils of LU 1 with slopes greater than 0.5 percent and soils of LU 6 with D horizons coarser than sandy clay are exceptions.

Generally the major problems associated with the solodic-solodized solonetz for crops other than rice are:

a) Low PAWC and high ESP;

b) Seedling emergence

c) Soil salinity

Low PAWC and high ESP. PAWC of the solodic-solodized solonetz of the area, measured by Gardner and Coughlan (1982), varied from 5.1 to 8.0 cm. The measured rooting depth varied from 0.4 to 0.6 m.. Elliot and McDonald (1987) measured the depth of wetting as > 0.9 m on the "Gaynor site" on soil type 1Dyc. However water extraction by maize and soybeans on this site did not exceed 0.6 m. This was attributed to the higher level of salts at depths greater than 0.6 m. Gardner and Coughlan (1982) also included soil strength and aeration as other soil properties which are likely to limit root growth in subsoils of heavy texture.

In the study area, the solodic-solodized solonetz with high ESP values (> 14) at or above 0.6 m usually have shallow A horizons (< 0.2 m) and overlie subsoils with high bulk densities (> 1.6 g cm^{-3}). Gardner and Coughlan (1982) showed that a throttle restricting water entry in the B horizon is present in these soils. This is caused largely by unfavourable structure, high ESP levels and high bulk density. Ripping of the subsoil is usually regarded as a means of removing this throttle and increasing infiltration and PAWC of these soils. However, Gardner and Coughlan (1982) showed that the depth of ripping is an important consideration, as the location and size of the throttle in the B horizon can vary, depending on the soil type. Shallow ripping (< 0.3 m) increased water accession to the deep subsoil in soil type 1Dya but not soil type 2Dyb. This indicated that only the upper part of the B horizon of soil type 1Dya was acting as a throttle. For 2Dyb, Gardner and Coughlan (1982), suggested that the whole B horizon may have been acting as a throttle or the absence of columnar structure (present in 1Dya) prevented water entry to the deep subsoil. However, in the same study, deep ripping (0.7-0.8 m) on soil type 2Dyb improved PAWC substantially from 8.0 cm to 15.8 cm, indicating that the throttle was rendered ineffective by ripping to this depth.

Deep ripping may only increase infiltration and PAWC for a short period. Smith and McShane (1981) stated that the voids created between the clods developed from ripping may close due to slaking of the soil between the voids. This is particularly so if the clods developed are small. Ripping of very dry soil with cutter blade rippers should form the more benefical larger clods.

Combining deep ripping with gypsum will modify the structure of the B horizon and create a better leaching environment (Smith and McShane 1981). The added gypsum prolongs the effects of deep ripping by stabilising water conducting pores and delays the reformation of the throttle.

Applications of 20t/ha of gypsum to a trial area growing maize on the Gaynor site (soil type 1Dyc) marginally increased hydraulic conductivity and PAWC of the soil. Yields were improved but these increases may not be economical at that rate of application (Elliot personal communication). Deep ripping and gypsum application to improve hydraulic conductivity and PAWC therefore may not be economical for grain cropping especially on soil types with high levels of ESP(> 14) at shallow depths (< 0.30 m) in the profile. These soil types would include 1Dya, 1Dyb, 1Dyc, 1Dda, 1Dba, 2Dba, 2Ddb, 2Dya, 4Dyh, 5Dyc, 5Dyd, 6Dbh and 6Dyj.

An application of 11t/ha of gypsum increased yields of sugar-cane in the first year by 38t/ha to 143t/ha compared to those yields from an area with no gypsum application (Ham personal communication). This rate of gypsum application may, therefore, be economically feasible for sugar-cane.

Levelling of solodic-solodized solonetz will also need to be considered carefully, especially on soil types with a thin A horizon, so that sodic B horizons will not be exposed at the surface. Exposure of sodic B horizons will not only cause problems with germination and emergence but will also affect PAWC.

Germination and emergence. Most solodic-solodized solonetz in the survey area will present problems with seedling emergence and germination.

Smith and McShane (1981) advocate the use of post-plant irrigation techniques to alleviate these problems. However, Elliot and McDonald (1987) experienced problems with this technique in obtaining satisfactory seedling establishment on the Gaynor site (1Dyc) on both a 0.1 percent and 0.49 percent furrow gradient. Slumping and slaking of the clods on the hills, resulting in overtopping of the furrows, was the main reason proposed for the poor establishment on the lower sloped bays. Gypsum additions may reduce this problem. The poor establishment on plots with the steeper gradient was caused by the limited hill wetting which resulted from the lower flow rate used in the furrows to reduce erosion.

When planting into wet soil, the use of planters with narrow seed openers and appropriate press wheels are required. Seed should be placed into moist soil at a shallow depth (Barnes personal communication).

Organic matter is important in stabilizing aggregates especially in soils with low amounts of clay (Baver 1956). Incorporation of stubble residues on the duplex soils is therefore important.

Applications of gypsum will also reduce the problems associated with emergence by improving structure and increasing water infiltration. Gardner and Coughlan (1982) suggest that the potential to form smaller aggregates is enhanced by increasing the clay content of the soil surface by incorporating the B horizon. However with solodic-solodized solonetz, where upper B horizons may have ESP levels > 14 percent, mixing of horizons may cause greater problems than by endeavouring to ensure the

B horizon is not included. Removing the A horizon of solodic-solodized solonetz and exposing the B horizon is therefore not encouraged, so levelling strategies on these soils will have to be considered carefully.

Soil salinity. Gardner and Coughlan (1982), Shaw et al. (1984) and Elliot and McDonald (1987) have shown that soil salinity is reduced after a number of years of irrigated crop production especially with flood irrigation of rice. Ponding, therefore, may improve water accession and PAWC and may reduce the effects of salinity on root proliferation. However, Gardner and Coughlan (1982) stated that unless the effects of the throttle limiting soil water recharge associated with the B horizons of solodic-solodized solonetz is reduced, these improvements in soil water accession may only be temporary.

The strategy of growing one or more rice crops may be a useful one to increase water accession for subsequent row crops. However Gardner and Coughlan (1982) warn that the leaching of salts from the soil profile will lead inevitably to a higher concentration of salts in the groundwater.

6.5.3 Other management problems.

Low general fertility. Low general fertility status is a common chemical limitation associated with most of the soils of the survey area. Generally, nitrogen and phosphate fertilisers will have to be applied to these soils. Potassium additions are required for some soils, especially solodic-solodized solonetz. Zinc is also required on soils which on levelling may have surfaces exposed with pH > 7.5.

Soil variability. Management problems due to soil variability may occur within compound UMAs and between small UMAs and adjoining UMAs. The soils and some areas concerned have been outlined in Section 6.3.

Where possible, Smith and McShane (1981) suggest that different soil types should be managed separately. Where this is impossible, Gardner and Coughlan (1982) suggest that irrigation frequencies should be matched to the soil type with the lower PAWC. Seed should be planted into dry soil and then watered. The properties of some adjacent soils are so dissimilar, however, that effective furrow irrigation will not be possible for optimum production (for example 5Uga and 5Dra, and uniform coarse sands with other soils).

6.5.4 On-farm degradation hazards

The major degradation hazards of salinisation and erosion have been discussed in Sections 2.3 and 6.3. The on-farm management strategies that can be used to decrease the incidence of these hazards are summarised below.

*Salinisation

- Spray irrigation, trickle irrigation or special furrow irrigation techniques should be used on intake areas to minimise deep drainage losses to groundwater with subsequent secondary salinisation downslope.

- Precision levelling must be undertaken, especially on near-level landscapes, to ensure that surface drainage is not impeded so as to minimise accession to groundwater and subsequent regional salinisation.

- On-farm channels and drains must be appropriately designed and prepared so that drainage losses to groundwater are kept to a minimum.

- Only necessary clearing of vegetation on sloping lands must be undertaken. Increasing vegetation in non-irrigated areas is advisable. The construction of on-farm water storages is not advisable unless these storages are lined so as to reduce losses to groundwater.

* Erosion

- All drainage ways must be grassed and adequately maintained.

- The gradient and length of irrigation furrows must be such that soil losses are kept to an acceptable level. On sloping lands, furrows may have to be angled across the maximum slope.

- Bare fallows should be avoided on sloping lands during the wet season.

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8. GLOSSARY

Landscape unit	A natural unit of land in which a particular soil or association of soils is developed from a single rock type (consolidated or unconsolidated) or complex of rock types. The soils bear a constant relationship with a limited range of landform elements or native vegetation communities and there is a similar drainage net throughout the soil landscape. These relationships have developed as a result of interactions between climate, rock types and geomorphic history (adapted from Thompson and Moore 1984).
Soil type	A three-dimensional soil body such that any profile within the body has a similar number and arrangement of major horizons whose attributes, primarily morphological, are within a defined range. All profiles within the soil type have similar parent materials (R.C. McDonald, personal communication).
Mapping unit	An area or group of areas, coherent enough to be represented to scale on a map, which can be adequately described in a simple statement in terms of its main soil types (adapted from Beckett and Webster 1971).
Agricultural management unit	A mapping unit or group of mapping units with similar land suitability classes, soil and land limitations and management requirements.

9. REFERENCES

Andrew, C. S., Crack, B. J. and Rayment, G. E. (1974), 'Queensland', in K.D. McLachlan, (ed.) Handbook of Sulphur in Australian Agriculture, CSIRO Australia, 55-63.

Archer, J. R. (1975). Soil consistency, in Soil Physical Conditions and Crop production, Great Britian Ministry, Agriculture, Fisheries and Food Technical Bulletin 29, 289-97.

Australian Bureau of Meteorology, Queensland Regional Office (1970), Climate, Burdekin-Townsville Region, Queensland, Resource Surveys, Department of National Development, Australia.

Awadhwal, N. K. and Thierstein, G. E. (1985), Soil crust and its impact on crop establishment: A review, Soil and Tillage Research 5, 289-302.

Barnes, J. E. and Reid, R. E. (1978), Effect of mid-season draining on paddy rice in the Lower Burdekin Valley, Queensland Journal of Agricultural Animal Science **35**, 159-67.

Baker, D. E. (1977), Chemical and Physical Properties of the Soils, in Soils of the Lower Burdekin River - Elliott River Area, North Queensland, Queensland Department of Primary Industries, Agricultural Chemistry Branch, Technical Report 10.

Baker, D. E., Rayment, G. E. and Reid, R. E. (1983), Predictive relationships between pH and sodicity in soils of tropical Queensland, Communications in Soil Science and Plant Analysis **14**, 1063-73.

Bakker, A. C. and Emerson, W. W. (1973), The comparative effects of exchangeable calcium, magnesium and sodium on some physical properties of red-brown earth subsoils. III The permeability of Shepparton soil and comparison methods, Australian Journal Soil Research, **11**, 159-65.

Basinski, J. J. (1978), Land Use on the South Coast of New South Wales, a study in methods of acquiring and using information to analyse regional land use options, General report, volume 1, CSIRO Australia.

Baver, L. D. (1956), Soil Physics, John Wiley and Sons, New York.

Beckett, P. H. T. and Webster, R. (1971), soil variability: a review. Soils and Fertilisers, **34**, 1-15.

Bruce, R. C. (1983), Soil chemical factors affecting crop production, in New Technology in Field Crop Production, Australian Institute Agricultural Science, Refresher Training Course, Lawes, January 1983.

Bruce, R. C. and Rayment, G. E. (1982), Analytical methods and interpretations used by the Agricultural Chemistry Branch for soil and land use surveys, Queensland Department of Primary Industries Bulletin QB 82004.

Burdekin Project Committee (1977), Resources and Potential of the Burdekin River Basin, Queensland, Australian Government Publishing Service, Canberra.

Burdekin Project Assessment Committee (1978), Report on Burdekin River Project, Queensland Government, Brisbane.

Carter, D. L., Berg, R. D. and Sanders (1985), The effect of furrow irrigation erosion on crop productivity, Soil Science Society America Journal **49**, 207-11.

Christian, C. S., Paterson, S. J., Perry, R. A., Slatyer, R. O., Stewart, G. A. and Traves, D. M. (1953), Survey of the Townsville-Bowen region North Queensland, CSIRO Australia, Land Research Series No. 2.

Colwell, J. D. (1963), The estimation of the phosphorus fertilizer requirements of wheat in southern New South Wales by soil analysis, Australian Journal of Experimental Agriculture and Animal Husbandry **3**, 190-97.

Coughlan, K. J. (1979), Influence of micro-structure on the physical properties of cracking clay soils, Report to Reserve Bank of Australia.

Coughlan, K. J. and Loch, R. J. (1984), The relationship between aggregation and other soil properties in cracking clay soils. Australian Journal of Soil Research **22**, 59-69.

Darab, K. (1980), Magnesium in solonetz soils. Symposium papers - International symposium on salt affected soils, Karnal, India, 1980, 92-101.

Donnollan, T. E., McClurg, J. I. and Tucker, R. J. (1986), Soils and land suitability of Leichhardt Downs Section, Burdekin River Irrigation Area, Part A, Queensland Department of Primary Industries, Land Resource Bulletin QV86001.

Donnollan, T. E. and Day, K. J. (1986), Land suitability for irrigation in the Burdekin River Irrigation Area, in Land Resources Branch Workshop, Kooralbyn Valley, 12-16 May 1986, Theme - Land suitability, Programme and draft papers.

Elliot, P. J. and McDonald, W. J. (1987), Gaynor Development Progress Report, wet season 1985-86. Queensland Department of Primary Industries, Gaynor Research site reports, RQT 87005.

Ellis, R. (1983), A preliminary report on the geology of the proposed Leichhardt Downs irrigation area, Queensland Water Resources Commission, unpublished report.

FAO (1985), Guidelines: land evaluation for irrigated agriculture, Soils Bulletin **55**, FAO, Rome.

Gardner, E. A. (1979), Soil structure of the Oakey - Barratta soils, in unpublished papers of an Emergence Workshop, Ayr, April 1979.

Gardner, E. A and Coughlan, K. J (1982), Physical factors determining soil suitability for irrigation crop production in the Burdekin-Elliot River area, Queensland Department of Primary Industries, Agricultural Chemistry Branch, Technical Report 20.

Gill, J. Y. (1984), Determining the quality of water for irrigation in Queensland, Queensland Department of Primary Industries Ref. note R1. Jan. 1984.

Gregory, C. M. (1969), Geology of the Ayr 1:250 000 sheet area, Report Bureau of Mineral Resources, Australia, 128.

Ham, G. J. (1985), Water consumption by sugar cane under commercial growing conditions, in Proceedings of Fifth Afro-Asian Regional Conference, Planning and Management of water for agriculture in the Tropics, Townsville, Australia 25-30 August 1985, International Commission of Irrigation and Drainage, 23-33.

Hodgson, A. S. and Chan, K. Y. (1982), The effect of short-term waterlogging during furrow irrigation of cotton in a cracking grey clay, Australian Journal Agricultural Research, **33**, 109-16.

Hopley, D. (1970), The geomorphology of the Burdekin delta, North Queensland, James Cook University of North Queensland, Department of Geography, Monograph Series. No. 1.

Hubble, G. D. and Thompson, C. H. (1953), The soils and land use potential of the Lower Burdekin Valley, North Queensland, CSIRO Australian Soils and Land Use Series, 10.

Isbell, R. F. and Murtha, G. G. (1970), Soils, Burdekin-Townsville Region, Queensland, Resource Series, Department of National Development, Canberra.

Isbell, R. F. and Murtha, G. G. (1972), Vegetation, Burdekin-Townsville Region Queensland, Resources Series, Department of National Development, Australia.

Kapitzke, I. R. (QWRC unpublished report), Burdekin River Irrigation Area, Leichhardt Section, Significant Historic Floods, QWRC Flood Inundation Studies.

Kelley, W. P. (1964), Soil properties in relation to exchangeable cations and kinds of exchange material, Soil Science **98**, 408-12.

Kerr, W. H. and Von Stieglitz, C. R. (1938), The laboratory determination of soil fertility, Bureau of Sugar Experiment Stations, Queensland, Technical Communication 9.

Landon, J. R. (ed.) 1984. Booker Tropical Soil Manual, A handbook for soil survey and agricultural land evaluation in the tropics and subtropics, Booker Agriculture International Limited.

Little, I. D. and Ward, W. T. (1981), Chemical and mineralogical trend in a chronosequence developed on alluvium in eastern Victoria, Australia, Geoderma **25**, 173-88.

Loveday, J. (1976), Relative significance of electrolyte and cation exchange effects when gypsum is applied to a sodic clay soil, Australian Journal Soil Research, **14**, 361-71.

Loveday, J. (1981), Soil management and amelioration, in T.S. Abbott, C. A. Hawkins and P. G. E. Searle (eds) National Soils Conference 1980 Review Papers, Australian Society Soil Science Inc., Glen Osmond, South Australia.

Loveday, J. and Bridge, B. J. (1983), Management of salt-affected soils, in Soils: an Australian viewpoint, Division of Soils, CSIRO, 843-55. (CSIRO: Melbourne/Academic Press:London).

Maltby, J. E. and McShane, T. J. (1988), Fertility studies on soils of the lower Burdekin area, north Queensland, 1, Lower Burdekin River-Elliot River area, Queensland Journal of Agricultural and Animal Sciences, **45**, 65-75.

Mass, E. V., and Hoffman, G. J. (1977), Crop salt tolerance - current assessment, Journal of the Irrigation and Drainage Division, Proceedings of the American Society of Civil Engineers, **102**, IR2 115-34.

Mikkelsen, D. S. and Shiou Kuo, (1976), Zinc fertilisation and behaviour in flooded soils, in The fertility of paddy soils and fertiliser application for rice, ASPAC Food Fertiliser Technology Centre, Taiwan, 170-96.

McCown, R. L., Murtha, G. G. and Smith, G. D. (1976), Assessment of available water storage capacity of soils with restricted subsoil permeability, Water Resources Research **12**, 1255-9.

McDonald, R. C. (1977), Soil horizon nomenclature, Queensland Department of Primary Industries, Agricultural Chemistry Branch, Technical Memorandum 1/77.

McDonald, R. C., Isbell, R. F., Speight, J. G., Walker, J. and Hopkins, M. S. (1984), Australian Soil and Land Survey Field Handbook, Inkata Press, Melbourne.

McDonald, W. J. (unpublished report), Commercial evaluation of Lower Burdekin Soils under irrigation, Fort Site Project, MRS-C65-AB.

McNeal, B. L., Layfield, D. A., Norvell, W. A. and Rhoades, J. D. (1968), Factors influencing hydraulic conductivity of soils in the presence of mixed-salt solutions. Soil Science Society America Proceedings **32**, 187-90.

Mullins, J. A. (1981), Estimation of the plant available water capacity of a soil profile, Australian Journal of Soil Research **19**, 197-207.

Northcote, K. H. (1979), A Factual Key for the Recognition of Australian Soils, 4th edition, Rellim Technical Publication, Glenside, South Australia.

Northcote, K. H and Skene, D. J. M (1972), Australian soils with saline and sodic properties, CSIRO Australian Division of Soils, Soil Publication 27.

Northcote, K. H., Hubble, G. D., Isbell, R. F., Thompson, C. H. and Bettenay, E. (1975), A description of Australian soils, CSIRO, Australia.

Oyama, M. and Takehara H. (1967), Revised Standard Soil Colour Charts, Fujihara Industry Co. Ltd, Tokyo.

Paine, A. G. L. (1972), Geology, Burdekin-Townsville region, Queensland, Resources Series, Department of National Development, Canberra.

Piper, C. S. and DeVries, M. P. C. (1960), The availability of potassium in some Tasmanian soils. 2. Exhaustive cropping in relation to potassium reserves in the soil, Australian Journal of Agricultural Research **11**, 774.

QWRC (1987), Burdekin River Irrigation Area, Flood Studies, Position Statement, March 1987, (unpublished report).

Reid, R. E. and Baker, D. E. (1984), Soils of the Lower Burdekin River-Barratta Creek-Haughton River Area, North Queensland, Queensland Department of Primary Industries, Agricultural Chemistry Branch Technical Bulletin 22.

Rengasamy, P., Greene, R. S. B., Ford, G. W., Jordan, P. and Mihanni, A. H. (1984), Evaluation of the gypsum requirement of red-brown earths, Department of Agriculture, Victoria, Research Project series 192.

Shaw, R. J. (1982), Lower Burdekin Right Bank - hydrology and salinity, Burdekin Workshop, Ayr, 17th November 1982, Queensland Department of Primary Industries. (unpublished report).

Shaw, R. J. and Yule, D. F. (1978), The assessment of soils for irrigation, Emerald, Queensland, Queensland Department of Primary Industries, Agricultural Chemistry Branch, Technical Report 13.

Shaw, R. J., Thorburn, P. J., McShane, T. J., Maltby, J. E. and Robson, C. K. (1982), The effectiveness of drainage in a region of variable aquifer hydraulic conductivity in the Lower Burdekin Region, North Queensland, in R. J. Smith and A. J. Rixon (eds.) Rural Drainage in Northern Australia, Proceedings of Symposium, Darling Downs Institute of Advanced Education, 129-42.

Shaw, R. J., Eldershaw, V. J., Thompson, W. P. and Smith, G. D. (1984), Changes in hydrology and salinity under Irrigation Agriculture on the Fort Site, Lower Burdekin Right Bank, North Queensland, Queensland Department of Primary Industries, Bulletin QB94004.

Shaw, R. J., Hughes, K. K., Dowling, A. J. and Thorburn, P. J. (1986) Principles of landscape, soil and water salinity - processes and management options. Part A in Landscape soil and water salinity. Proceedings of the Burdekin regional salinity workshop, Ayr, April 1986. Queensland Department of Primary Industries Publication QC 86003

Smith, G. D., Couglan, K. J. and Fox, W. E. (1978), The role of texture in soil structure, in W. W. Emerson, R. D. Bond and A. R. Dexter (eds.) Modification of Soil Structure, Chapter 9, Chichester and Wiley.

Smith, G. D. and McShane, T. J. (1981), Modification and management of irrigated soils in the Lower Burdekin Valley, Queensland, Queensland Department of Primary Industries, Agricultural Chemistry Branch, Technical Report 17.

Skerman, P. J. (1951), Tenative soils map, Lower Burdekin, in The Burdekin River Irrigation, Hydro-Electric and Flood Migration Project, Burdekin River Authority.

Soil Survey Staff (1951), Soil Survey Manual, United States Department of Agriculture, Agricultural Handbook 18, (US Government Printer, Washington).

Spain, A. V., Isbell, R. F. and Probert, M. E. (1983), Soil organic matter, in Soils: an Australian viewpoint, Division of Soils, CSIRO, CSIRO; Melbourne/Academic Press: London, 551-64.

Specht, R. L. (1970), Vegetation, in G. W. Leeper (ed). The Australian Environment, CSIRO in association with Melbourne University Press: Melbourne, 46-7.

Stace, H. C. T., Hubble, G. D., Brewer, R., Northcote, K. H., Sleeman, J. R., Mulcahy, M. J. and Hallsworth, E. G. (1968), A Handbook of Australian Soils, Rellim Technical Publication, Glenside, South Australia.

Thompson, W. P. (1977), Soils of the Lower Burdekin River - Elliot River area North Queensland, Queensland Department of Primary Industries, Agricultural Chemistry Branch Technical Report 10.

Thompson, W. P. (1980), Toposequence salinization In the Lower Burdekin region, in A. J. Rixon and R. J. Smith (eds.). Salinity and Water Quality, Proceedings of Symposium, Darling Downs Institute of Advanced Education, Toowoomba, Queensland 31-46.

Thompson, W. P. and Reid, R. E. (1982), Soil profile classes of the Lower Burdekin Valley, Queensland Department of Primary Industries, Agricultural Chemistry Branch, Technical Report 21.

Thompson, C. H. T and Moore, A. W. (1984), Studies in landscape dynamics in the Cooloola - Noosa River Area, Queensland. I. Introduction, general description and research approach, CSIRO, Australia, Division of Soils, Divisional Report 73.

Thompson, W. P., Baker, D. E., Cannon, M. G. and Reid, R. E. (in preparation), Soils of the Lower Burdekin Valley, North Queensland - Redbank Creek to Bob's Creek and south. Queensland Department of Primary Industries, Agricultural Chemistry Branch Technical Report.

United States Salinity Laboratory (1954), Diagnosis and improvement of saline and alkali soils, United States Department of Agriculture, Agricultural Handbook 60, (US Government Printer, Washington).

Van Wijk, C. (1971), Farm production and returns - Soils. In Report on extension of Burdekin River irrigation project. Queensland Department of Primary Industries and Queensland Irrigation and Water Supply Commission, Brisbane.

Viets, F. G. Jr., and Lindsay, W. V. (1973), Testing soils for zinc, copper, manganese and iron'. Chapter 11, in L.M. Walsh and J.D. Beaton, (eds). Soil Testing and Plant Analysis, rev. ed., Soil Science Society of America Incorporated, Madison, Wisconsin.

von Stieglitz, C. R. (1946), Soil fertility surveys with particular reference to the Garradunga area in North Queensland. Proceedings of the Queensland Society of Sugar-Cane Technologists, 127.

Walkley, A. and Black, I. A. (1934), An examination of the Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method, Soil Science **27**, 29-38.

Williams, C. H. and Lipsett, J. (1960), The build up of available potassium under subterranean clover pastures on a podzolic soil, Australian Journal of Agricultural Research **8**, 179.

Wischmeier, W. H. and Smith, D. D. (1978), Predicting rainfall erosion losses - a guide to conservation planning. United States Department of Agriculture, Agricultural Handbook 537.

Yule, D. F. (1986), Irrigation management for efficient water use, in Irrigation management workshop, Queensland Agriculture College, 24-27 June, 1986.

Yule, D. F., Coughlan, K. J. and Fox, W. E. (1976), Factors affecting seedbed properties of cracking clay soils of the Darling Downs, Australian Journal Experimental Agriculture and Animal Husbandry **16**, 771-4.

APPENDIX I VEGETATION - COMMON AND SCIENTIFIC NAMES

Trees:	
Beefwood	Grevillea striata
Cabbage gum	Eucalyptus papuana
Carbeen	E. tessellaris
Cocky apple	Planchonia careya
Grey bloodwood	Eucalyptus polycarpa
Ironbark	E. drepanophylla
Pandanus	Pandanus spp.
Poplar gum	Eucalyptus alba
Red bloodwood	E. dichromopholia
Tea-tree	Melaleuca nervosa
Shrubs:	
Beefwood	Grevillea striata
Broad leaf tea-tree	Melaleuca viridiflora
Corkwood wattle	Acacia bidwillii
Currant bush	Carissa ovata
Currant bush	C. lanceolata
False sandalwood	Eremophila mitchellii
Jerusalem thorn	Parkinsonia aculeata
Mimosa bush	Acacia farnesiana
Prickly acacia	A. nilotica
Quinine bush	Petalostigma pubescens
Rubber vine	Cryptostegia grandiflora
Species of Isolated Occurrence:	
Bauhinia	Lysiphyllum carronii
Bauhinia	L. hookeii
Bulloak	Causuarina luehmannii
Burdekin Plum	Pleiogynium timorense
Chinee apple	Ziziphus mauritiana
Coral tree	Erythrina vespertilio
Dead finish	Albizia basaltica
Prickly pine	Bursania incana
Whitewood	Atalaya hemiglauca
Willow wattle	Acacia salicina
Leichhardt tree	Sorcocephalus coadunatus
Yellow wood	Terminalia oblongala
Grasses:	
Black spear grass	Heteropogon contortus
Blady grass	Imperata cyclindrica
Blue grasses	Bothriochloa and Dicanthium spp.
Brown sorghum	Sorghum nitidum
Brown top	Eulalia fulva
Cane grass	Ophiurous exaltatus
Flinders grass	Iseilema spp.
Giant spear grass	Heteropogon triticeus
Golden beard grass	Chrysopogon fallax
Kangaroo grass	Themeda australis
Love grasses	Eragrostis spp.

APPENDIX I (Continued)

Panicum	Panicum spp.
Para grass	Brachiaria mutica
Purple top Rhodes grass	Chloris barbata
Red natal grass	Rhynchelytrum repens
Rhodes grass	Chloris gayana
Wire grass	Aristida spp.
Sedges:	
Sedge	Cyperus spp.

APPENDIX II DETAILED DESCRIPTIONS OF THE MORPHOLOGY OF THE SOIL TYPES

(a) Horizon nomenclature as per McDonald (1977).

(b) The pH profiles are based on field determinations made at 0.05, 0.3 0.6, 0.9, 1.2 and 1.5 m depths.

(c) Principal Profile Forms (Northcote 1979) are listed in order of decreasing frequency of occurrence.

(d) Soil types have been placed in Great Soil Groups (Stace et al. 1968) where possible. Bracketed qualifiers have been used to distinguish variations to Great Soil Groups. Where soils cannot be placed in a Great Soil Group, soil names of Northcote et al. (1975) have been used.

(e) Moist colours are those of Oyama and Takehara (1967). Where value/chroma ratings are separated by "to" the full range of ratings are inferred. (For example 10YR 2/1 to 4/2 includes 10YR 2/1, 2/2, 3/1 3/2, 4/1 and 4/2). Colour nomenclature is that of R.C. McDonald (personal communication) based on the Value/Chroma ratings system of Northcote (1979) and utilising the following table:

Value/chroma rating group 2a= 4/1 - 4/2 to 6/1 - 6/2
Value/chroma rating group 2b= 5/3 - 5/4 to 6/3 - 6/4

Value/Chroma rating group	1	2a	2b	4	5
Hue					
10 R	dark	red-grey	red-brown	red	red
2.5 YR	dark	grey-brown	red-brown	red	red
5 YR	dark	grey-brown	brown	red-brown	red-brown
7.5 YR	dark	grey-brown	brown	yellow-brown	brown
10 YR	dark	grey	yellow-brown	yellow	brown
2.5 Y	dark	grey	yellow-grey	yellow	olive-brown
5 Y	dark	grey	yellow-grey	yellow	olive

(f) Self mulch:

Weak - < 1 cm depth of poorly developed self mulch.
Moderate - 1-2 cm depth of discrete aggregates breaking to granular peds.
Strong - > 1-2 cm depth of discrete aggregates breaking to granular peds.

(g) Mottling:

Weak - < 10 per cent
Moderate - 10 to 25 per cent
Strong - > 25 per cent

APPENDIX II (Continued)

(h) Horizon boundaries:

_____ indicates horizon below is always present.

-------- indicates horizon below is not always present.

(i) Gilgai:

Incipient - < 0.05 m vertical interval.
Weak - 0.05 to 0.1 m vertical interval.
Moderate - 0.1 to 0.3 m vertical interval.
Strong - > 0.3 m vertical interval.

(j) Structure:

As per Soil Survey Staff (1951)
Lenticular size categories defined as for prismatic.

(k) Frequency of occurrence:

Frequently - on 40 to 80% of occasions.
Occasionally - on 20 to 40% of occasions.

(l) Vegetation:

Structural forms as per Specht (1970).

(m) Consistence:

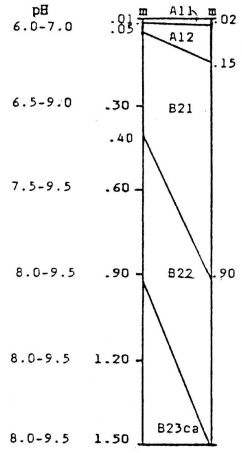
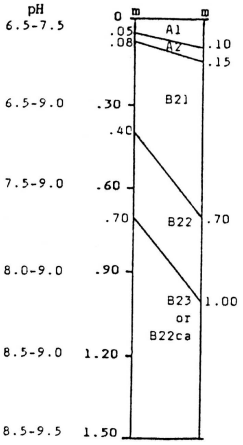
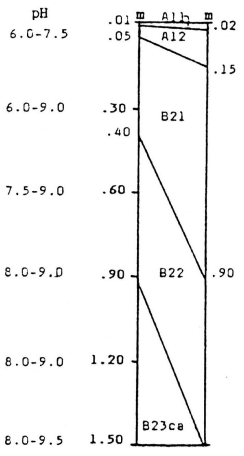
Soft - very small force to break 0.02 m lumps of soil
Slightly hard - small but significant force to break 0.02 m lumps of soil.
Hard - moderate force to break 0.02 m lumps of soil.
Very hard - strong force but within power of thumb and forefinger.
Extremely hard - very strong force, beyond power of thumb and forefinger.

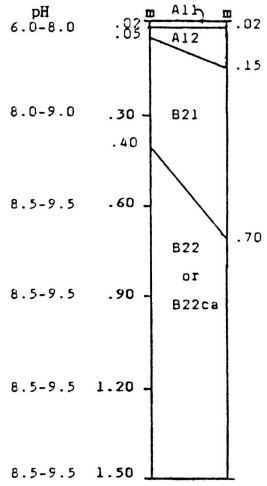
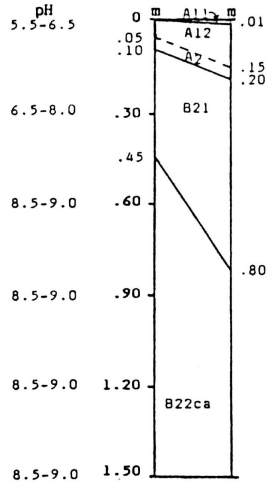
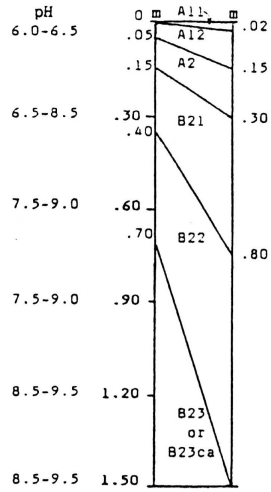
(n) Abundance of segregations:

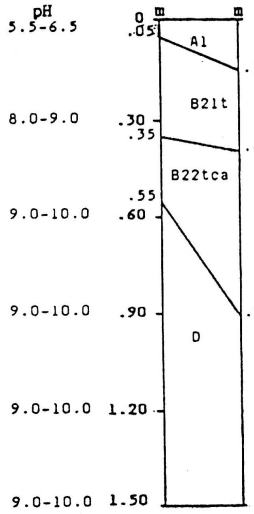
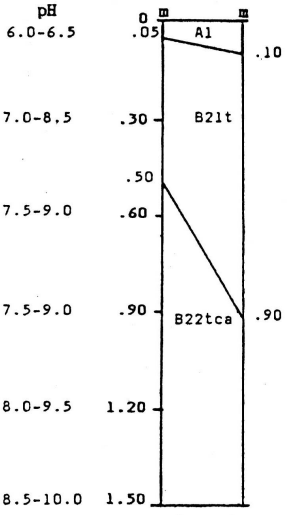
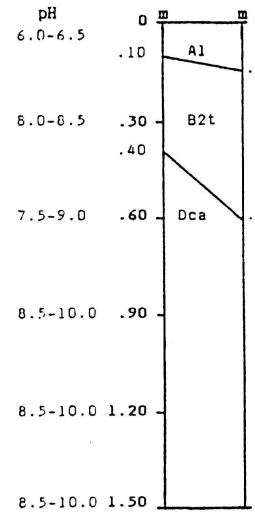
Trace - < 1 per cent
Small - 1 to 5 per cent
Moderate - 5 to 10 per cent
Large - > 10 percent

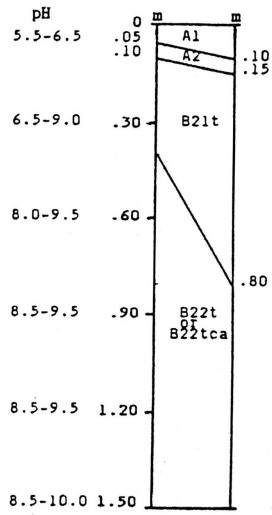
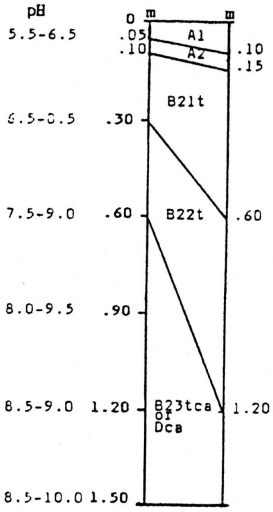
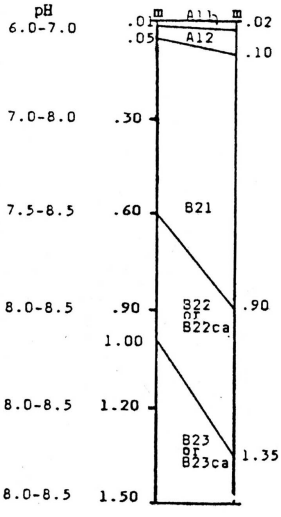
(o) Hardsetting as per Northcote (1979).

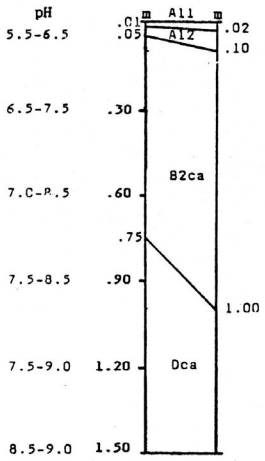
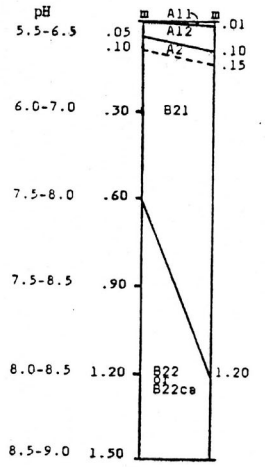
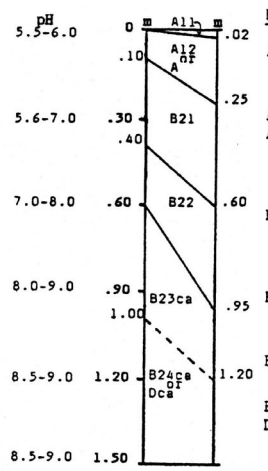
(p) Texture determined in the field as per Northcote (1979).

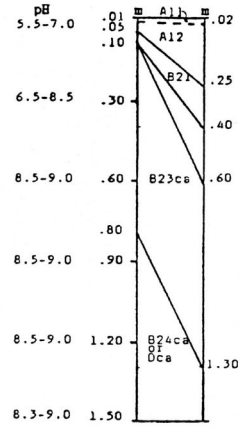
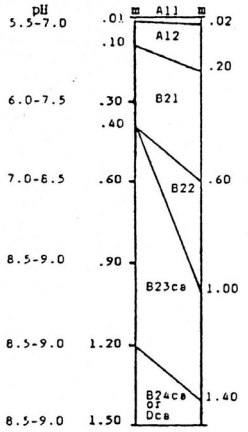
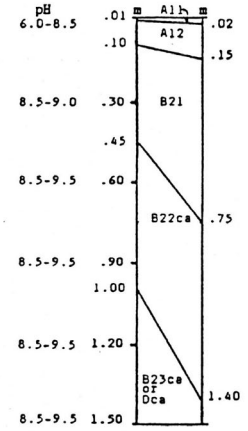
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
1Uga	Ug5.16 Ug5.24 Ug5.28		Black earth - grey clay: Weak to moderate gilgai, moderately cracking. Mound: A11: Weak to moderate, medium to fine granular self mulch. A12: Occasionally weakly brown-mottled dark to grey (10YR 2/1 to 3/2, 4/1); light medium to medium clay; moderate to strong, medium to fine subangular blocky to blocky; dry very hard. Clear to - B21: Dark to grey (10YR, 2.5Y 2/1 to 4/1), medium to medium heavy clay; strong, fine prismatic to medium to fine lenticular to blocky; dry extremely hard. Gradual to diffuse to - B22: As above but grey (10YR, 2.5Y 4/1 to 5/2). Clear to - B23ca: Occasionally moderately yellow-mottled grey to yellow-brown (10YR, 2.5Y 5/1, 5/2, 5/3 to 6/4); medium to medium heavy clay; strong, fine prismatic to blocky to medium to fine lenticular; dry extremely hard; trace to moderate amounts of concretionary carbonate. Subrounded and rounded pebbles throughout. Ferromanganiferous nodules throughout. Trace of concretionary carbonate may be present from the surface. Depression: Similar morphology but greater depth to carbonate and usually lower pH in upper B horizons.	Local alluvial plains and associated pediments. Low lying flats and drainage depressions	Low open woodland of poplar gum and carbeen with cabbage gum, beefwood and broad leaf tea-tree associated with Tussock grassland of cane grass and blue grasses
1Ugc	Ug5.16 Ug5.15 Ug5.24 Ug5.28 Ug3.1 Ug2 Ug3.2		Black earth-grey clay-(bleached) black earth-(bleached) grey clay: Weak gilgai, weakly cracking, hard setting surface. Mound: A1: Frequently brown-mottled dark to grey (7.5YR, 10YR 2/1 to 4/1); light to light medium clay; weak to moderate, medium to fine granular to blocky to subangular blocky; dry hard. Abrupt to clear to - A2: (occasionally present) As above with conspicuous or sporadic bleach. Abrupt to clear to - B21: Dark to grey (10YR, 2.5Y 2/1 to 4/1); medium to medium heavy clay; strong, medium prismatic to blocky to lenticular; dry very hard. Gradual to diffuse to - B22: As above but (10YR, 2.5Y 3/1 to 5/2). Clear to gradual to - B23 or B22ca: Grey to yellow-brown (10YR, 2.5Y 4/1 to 6/2, 4/3 to 5/4); medium to medium heavy clay; strong, medium lenticular to fine blocky; dry very hard; frequently small to moderate amounts of concretionary or soft carbonate. Subrounded and rounded pebbles throughout. Ferromanganiferous nodules throughout B horizon. Trace to small amounts of concretionary carbonate may be present from .40m. Depression: Similar morphology but greater depth to carbonate.	Local alluvial plains and associated pediments Low lying flats and drainage depressions	Low open woodland of poplar gum and cabbage gum with carbeen, beefwood and broad leaf tea-tree associated with Tussock grassland of blue grasses, brown top and cane grass
1Ugd	Ug5.28 Ug5.24 Ug5.29		Grey clay: Weak to moderate gilgai, weakly to moderately cracking. Mound: A11: Weak, medium granular self mulch. A12: Weakly to moderately brown-mottled grey to dark (10YR, 2.5Y 2/2 to 4/2, 4/1); light medium to medium clay; moderate to strong, medium prismatic to medium to fine subangular blocky to blocky; dry hard to very hard. Clear to - B21: Occasionally moderately yellow-mottled grey (10YR, 2.5Y 4/1, 4/2); medium to medium heavy clay; strong, medium subangular blocky to blocky; dry extremely hard. Gradual to diffuse to - B22: Occasionally weakly yellow-mottled grey to yellow-brown (10YR, 2.5Y 4/1 to 6/2, 5/3 to 6/4); medium to medium heavy clay; strong, medium to fine lenticular to blocky; dry extremely hard. Clear to - B23ca: As above with small to moderate amounts of concretionary or soft carbonate. Subrounded and rounded pebbles throughout. Ferromanganiferous veins and nodules throughout. Trace to small amounts of soft and concretionary carbonate may be present throughout B horizon. Depression: Similar morphology but colours usually greyer and greater depth to carbonate.	Local alluvial plains and associated pediments Low lying flats and drainage depressions	Low open woodland of poplar gum and carbeen with cabbage gum and beefwood Broad leaf tea-tree may be dominant or associated in poorly drained areas with Tussock grassland of blue grasses and cane grass with brown top and black spear grass associated

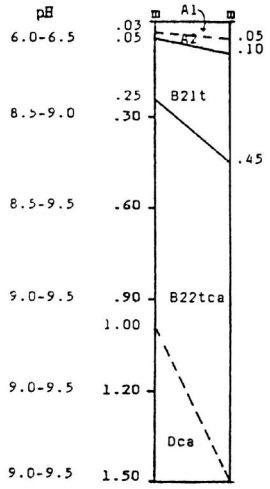
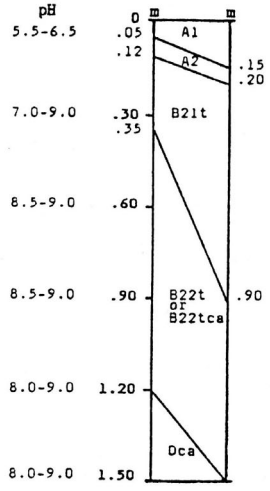
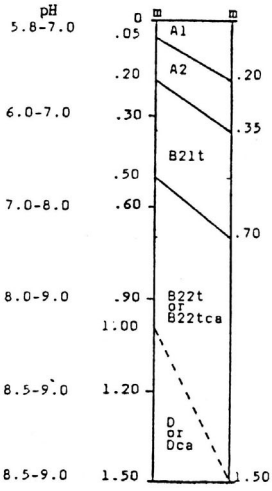
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
1Uge	Ug5.24 Ug5.28 Ug5.29 Ug5.16		Grey clay-black earth: Linear gilgai, weakly to strong cracking. Mound: A11: Weak to moderate, medium to fine granular self mulch. A12: Occasionally weakly brown-mottled grey to dark (10YR 3/1 to 4/2); light to medium clay; strong, medium to fine blocky; dry hard; trace amounts of concretionary and soft carbonate. Clear to - B21: Grey to dark (10YR, 2.5Y 4/1, 4/2, 5/2, 3/1); medium to heavy clay; strong, medium to fine prismatic to blocky; dry very hard; trace amounts of concretionary and soft carbonate. Gradual to - B22ca or B22: Yellow-brown to grey (10YR, 2.5Y 4/1, 4/2, 5/2, 5/3 to 6/4); medium to heavy clay; strong, medium to fine lenticular to blocky; dry very hard; small to trace amounts of concretionary and soft carbonate. Subrounded and rounded pebbles and ferromanganiferous nodules throughout. Subrounded to angular cobble and medium to large pebbles frequently on surface. Concretionary carbonate on surface.	Local alluvial plains and associated pediments Pediments with linear gilgai	Low open woodland of poplar gum and cabbage gum with beefwood associated with Tussock grassland of cane grass, black spear grass and blue grasses
1Uge	Ug5.16 Ug5.24 Ug5.28 Ug3.1 Ug2		Black earth-grey clay-(bleached) black earth-(bleached) grey clay: Linear gilgai, weakly to moderately cracking. Depression: A11: (frequently present) Weak to moderate, medium to fine granular self mulch (when absent surface is hard setting). A12: Dark to grey (7.5YR, 10YR 1.7/1 to 4/1); light to light medium clay; moderate to strong, medium to fine blocky; dry hard. Abrupt to clear to - A2: (occasionally present) As above with sporadic or conspicuous bleach. Abrupt to - B21: Dark to grey (7.5YR, 10YR, 2.5Y 1.7/1 to 4/1); light medium to heavy clay; strong, medium to fine prismatic to blocky; dry very hard. Clear to - B22ca: Yellow-brown to grey (10YR, 2.5Y 4/2, 5/2, 4/4 to 6/4); medium to medium heavy clay; strong, medium to fine lenticular to blocky; dry very hard; small amounts of concretionary and soft carbonate. Subrounded and rounded pebbles and ferromanganiferous nodules throughout B horizon. Variations: Texture of A horizon clay loam (Dd1.33, Dd1.43). Surface non-cracking (Uf6.31).	Local alluvial and associated pediments Pediments with linear gilgai	Low open woodland of poplar gum and cabbage gum with beefwood associated with Tussock grassland of cane grass, black spear grass and blue grasses
1Ugf	Ug3.2 Ug2		(Bleached) grey clay: Weak to moderate gilgai, weakly cracking. Mound: A11: (occasionally present) Weak, medium granular self mulch (when absent surface is hard setting). A12: Occasionally bleached, moderately brown-mottled dark to grey (10YR 3/1, 4/1, 4/2); light to light medium clay; weak to moderate, medium to fine blocky; dry hard. Abrupt to clear to - A2: As above with conspicuous or sporadic bleach. Abrupt to clear to - B21: Occasionally moderately brown-mottled grey (10YR, 2.5Y 4/1 to 5/2); medium clay; strong, medium prismatic to blocky to lenticular; dry very hard. Gradual to - B22: Grey to yellow-grey (10YR, 2.5Y 4/1 to 5/2, 5/3); medium to medium heavy clay; strong, medium lenticular to blocky; dry very hard. Clear to - B23 or B23ca: Grey to yellow-grey (10YR, 2.5Y 4/1 to 5/2, 5/3 to 6/4); medium to medium heavy clay; strong, medium lenticular to blocky; dry very hard; occasionally small to moderate amounts of concretionary and soft carbonate. Subrounded and rounded pebbles throughout. Ferromanganiferous veins and nodules throughout. Trace amounts of concretionary carbonate may be present from 0.30m. Depression: Similar morphology but A horizon may be strongly mottled and texture may be medium clay. A2 horizon usually with conspicuous bleach. B21 horizon dark to grey (10YR, 2.5Y, 3/1, 4/1).	Local alluvial plains and associated pediments Low lying flats and drainage depressions	Low open woodland of poplar gum and cabbage gum with carbeen, beefwood and broad leaf tea-tree associated with Tussock grassland of blue grasses, black spear grass and brown top

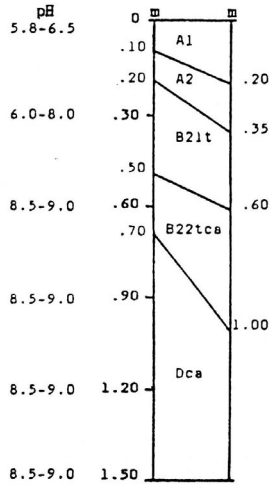
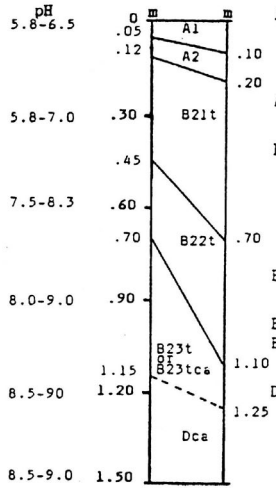
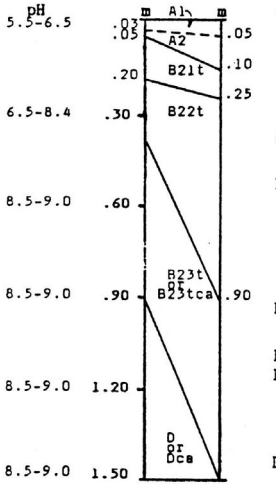
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
1Dba	Db1.33 Db1.43 Db2.33 Db2.43		Brown solodic-solodized solonetz: Hard setting surface. A1: Brown to dark (7.5YR, 10YR 3/1,3/3, 4/3, 4/4); clay loam; massive; dry hard; sporadic or conspicuous bleach throughout or near base. Abrupt to - B21t: Occasionally moderately yellow-mottled brown (7.5YR, 10YR 3/3, 3/4, 4/4, 4/6); medium to medium heavy clay; strong, medium columnar to blocky breaking to medium to fine subangular blocky to blocky; dry extremely hard. Clear to - B22tca: As above with small amounts of concretionary carbonate. Clear to - D: Yellow-brown (10YR 5/3, 5/4, 6/4); light to light medium clay; strong, medium to fine prismatic to blocky to subangular blocky; dry very hard; trace amounts of concretionary carbonate. Subrounded and rounded pebbles throughout. Ferromanganiferous nodules throughout B horizon.	Local alluvial plains and associated pediments Pediments and slightly elevated flats	Low open woodland of cabbage gum and beefwood with false sandlewood and broad leaf tea-tree associated with Open tussock grassland of blue grasses and black spear grass
1Dya	Dy2.33 Dy2.43		Grey solodic-solodized solonetz: Hard setting surface. A1: Dark to grey (10YR, 2.5Y 2/2, 3/2, 4/1, 4/2); sandy clay loam to clay loam; massive; dry hard; sporadic or conspicuous bleach throughout or near base. Abrupt to - B21t: Grey to yellow-brown (10YR, 2.5Y 4/2 to 6/2, 5/3, 5/4); light medium to medium clay; strong, coarse columnar to prismatic; dry extremely hard. Clear to - B22tca: Occasionally weakly brown-mottled grey to brown (7.5YR, 10YR 5/1 to 5/4, 4/4, 4/6); medium clay; strong, medium to fine prismatic to subangular blocky to blocky; dry extremely hard; small amounts of concretionary carbonate. Subrounded and rounded pebbles throughout. Ferromanganiferous nodules throughout B horizons.	Local alluvial plains and associated pediments Pediments and slightly elevated flats	Low to tall scrubland of false sandalwood and beefwood or Low open woodland of cabbage gum, poplar gum and scattered false sandalwood with Open to sparse tussock grassland of black spear grass and blue grasses
1Dyb	Dy2.33 Dy2.43		Grey solodic-solodized solonetz: Hard setting surface. A1: Occasionally weakly brown-mottled dark to grey or brown (7.5YR, 10YR 2/2,3/2, 4/2, 4/3); sandy loam to clay loam; massive; dry hard; sporadic or conspicous bleach throughout or near base. Abrupt to - B2t: Grey to yellow-brown (7.5YR, 10YR 4/1 to 5/2, 6/2, 5/3); light to light medium clay; strong, coarse columnar to prismatic to blocky breaking to fine prismatic and subangular blocky; dry extremely hard. Abrupt to clear to - Dca: Yellow-brown to light grey (10YR, 2.5Y 5/3 to 6/4, 7/4); sandy clay loam to light clay; weak to strong, medium to fine subangular blocky to blocky; dry very hard; small amounts of concretionary carbonate. Subrounded and rounded pebbles throughout. Ferromanganiferous nodules throughout B horizon.	Local alluvial plains and associated pediments Pediments and slightly elevated flats	Low woodland to low open woodland of cabbage gum, poplar gum, carbeen, beefwood and false sandalwood with Tussock grassland of black spear grass and blue grasses

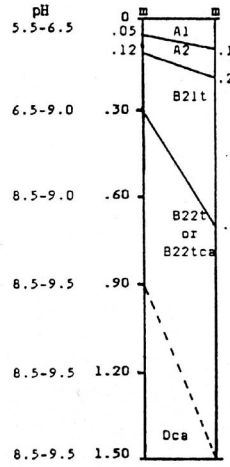
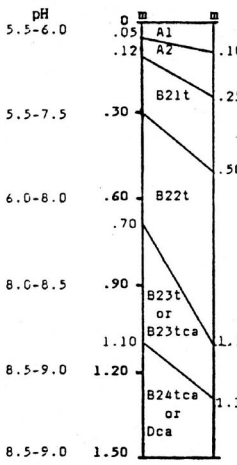
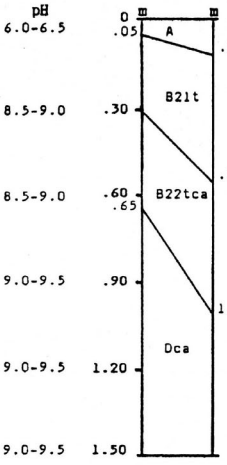
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
1Dyc	Dy2.43 Dy2.33 Dy3.43 Dy3.33		Grey solodic-solodized solonetz: Linear gilgai occasionally occurs, hard setting surface. A1: Frequently weakly to moderately brown-mottled dark to grey or brown (7.5YR, 10YR 3/2, 4/2 4/3, 4/4); clay loam to fine sandy clay loam; massive to weak, fine subangular blocky to blocky; dry hard. Abrupt to - A2: As above with conspicuous or sporadic bleach. Abrupt to - B21t: Occasionally moderately brown-mottled grey (10YR, 2.5Y 4/1 to 5/2); medium to medium heavy clay; strong, coarse columnar to prismatic to blocky breaking to medium to fine lenticular, blocky or prismatic; dry extremely hard. Clear to - B22t or B22tca: Grey to yellow-brown (10YR, 2.5Y 4/2, 5/2 to 6/4); medium clay; strong, medium to fine lenicular to prismatic to blocky; dry extremely hard; trace to moderate amounts of soft and concretionary carbonate. Subrounded and rounded pebbles throughout. Ferromanganiferous nodules throughout B horizon. Variant: Dyc3. Texture of A horizon light clay (Uf3, Ug2).	Local alluvial plains and associated pediments Pediments and slightly elevated flats	Low open woodland of cabbage gum, poplar gum and beefwood with carbeen and false sandalwood associated with Tussock grassland of blue grasses and black spear grass
1Dda	Dd1.33 Dd1.43 Db1.33		Dark and brown solodic-solodized solonetz: Hard setting surface. A: Frequnetly weakly brown-mottled dark to grey (7.5YR, 10YR 1.7/1, 3/1 to 4/2); clay loam; massive to weak, fine subangular blocky to blocky; dry hard. Abrupt to - A2: Frequently weakly brown-mottled grey to dark (7.5YR, 10YR 3/2, 4/2); clay loam; massive; dry hard; sporadic or conspicuous bleach. Abrupt to - B21t: Dark to brown (7.5YR, 10YR 2/1, 3/1, 3/2 3/3); medium to medium heavy clay; strong, coarse columnar or prismatic to blocky breaking to fine lenticular to subangular blocky to blocky; dry extremely hard. Gradual to diffuse to - B22t: Dark to grey (10YR, 2.5Y 3/1, 3/2, 4/1, 4/2); medium to medium heavy clay; strong, medium to fine lenticular to blocky; dry extremely hard. Clear to - B23tca or Dca: Grey to yellow-brown (10YR, 2.5Y 4/1, 4/2 to 6/2, 5/3 to 6/4); light to medium clay; strong, medium to fine lenticular to blocky; dry extremely hard; small to moderate amounts of concretionary and soft carbonate. Subrounded and rounded pebbles throughout. Ferromanganiferous nodules throughout B horizon.	Local alluvial plains and associated pediments Pediments and slightly elevated flats	Low open woodland of poplar gum and carbeen with cabbage gum, beefwood and willow wattle associated with Tussock grassland of black spear grass and blue grasses with kangaroo grass associated
2Uga	Ug5.25 Ug5.29 Ug5.15 Ug5.24 Ug5.28		Grey clay-black earth: Weak gilgai, moderately cracking. Mound: A11: Weak to moderate medium to fine granular self-mulch. A12: Frequently moderately brown-mottled grey to dark (10YR, 2.5Y 3/1, 4/1, 4/2); medium to medium heavy clay; strong, medium to fine subangular blocky; dry extremely hard. Clear to - B21: Grey to dark (10YR, 2.5Y 3/1, 4/1, 4/2); medium to medium heavy clay; strong, medium to fine subangular blocky to lenticular; dry extremely hard. Clear to - B22 or B22ca: As above with trace to small amounts of concretionary carbonate. Gradual to diffuse to- B23 or B23ca: Brown (7.5YR, 10YR 4/3 to 5/4); medium to medium heavy clay; strong, medium to fine lenticular; dry extremely hard; trace to small amounts of concretionary carbonate. Ferromanganiferous nodules througout B horizons. Depression: Similar morphology but A horizon moderately to strongly mottled.	Burdekin River alluvial plain Low lying flats	Low open woodland to low woodland of carbee and poplar gum with broad leaf tea-tree an beefwood associated with Tussock grassland of cane grass and blue grasses

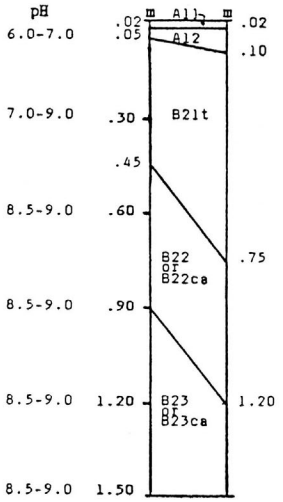
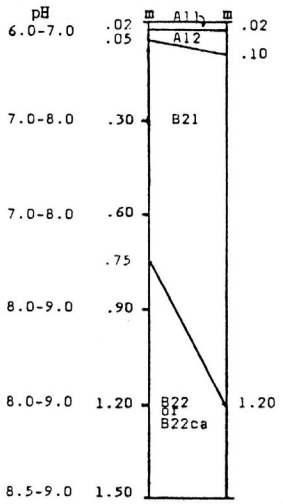
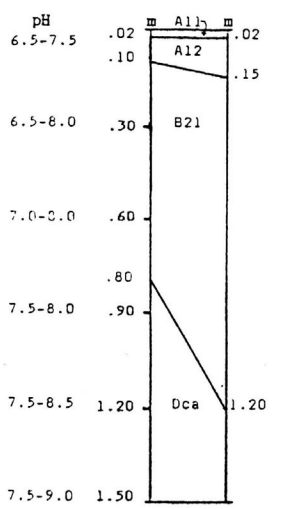
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
2Ugb	Ug5.17 Ug5.2		Black earth-grey clay: Weak gilgai, weakly to moderately cracking. A11: Weak to moderate, medium to fine granular self-mulch. A12: Weakly brown-mottled dark to grey (10YR 3/2 to 4/1, 4/2); light to light medium clay; strong, medium to fine subangular blocky; dry extremely hard. Clear to - B2ca: Dark to grey (10YR 3/2 to 4/1, 4/2); medium to medium heavy clay; strong, medium to fine subangular blocky to lenticular; dry extremely hard; small amounts of concretionary carbonate. Gradual to diffuse to - Dca: Brown to yellow-brown (7.5YR, 10YR 4/3 to 5/4); light to medium clay; weak to moderate, medium to fine subangular blocky; dry very hard; small amounts of concretionary carbonate. Ferromanganiferous nodules throughout B and D horizons. Depression: Similar morphology but A horizon moderately to strongly mottled and greater depth to carbonate and lower pH in B or D horizon.	Burdekin River alluvial plain Low lying flats	Low open woodland of poplar gum and carbeen with broad leaf tea-tree associated with Tussock grassland of cane grass and blue grasses
2Ugc	Ug5.28 Ug5.29 Ug5.24 Ug5.25 Ug5.35 Ug5.34 Ug3.2		Grey and brown clay, (bleached) grey clay: Weak to moderate gilgai, weakly cracking. Mound: A11: (occasionally present) Weak, medium to fine granular self-mulch (when absent, surface is hard setting). A12: Weakly to moderately brown-mottled dark to grey (10YR 3/2 to 4/2); light to light medium clay; moderate to strong, medium to fine subangular blocky; dry extremely hard. Abrupt to clear to - A2: (occasionally present) As above with sporadic bleach. Abrupt to - B21: Occasionally moderately brown-mottled grey to brown (10YR, 2.5Y 4/1, 4/2, 3/3); medium to medium heavy clay; strong, medium to fine subangular blocky to lenticular; dry extremely hard. Gradual to diffuse to - B22 or B22ca: Grey to brown (10YR, 2.5Y 4/1 to 4/6); medium to medium heavy clay; strong, medium to fine lentiuclar to subangular blocky; dry extremely hard; occasionally trace to small amounts of concretionary carbonate. Ferromanganiferous nodules throughout B horizons. Depression: Similar morphology but A horizon strongly mottled and frequently bleached.	Burdekin River alluvial plain Low lying flats	Low open woodland to low woodland of poplar gum with cabbage gum, carbeen, scattered broad leaf tea-tree and beefwood associated with Tussock grassland of cane grass and blue grasses
2Ugd	Ug3.2 Ug3.3 Ug3.1 Ug2		(Bleached) grey and brown clay and (bleached) black earth: Moderate to strong gilgai, weakly to moderately cracking. Mound: A11: (occasionally present) Weak, medium to fine granular self-mulch (when absent, surface is hard setting). A12 or A2: Moderately brown-mottled grey to dark (10YR 2/2 to 4/2); light to light medium clay; moderate, medium blocky; dry hard; sporadic or conspicuous bleach throughout or near base. Abrupt to clear to - B21: Moderately brown-mottled grey to brown or dark (10YR, 2.5Y 3/2, 4/1 to 5/2, 4/3); medium to medium heavy clay; strong, medium blocky; dry very hard. Gradual to diffuse to - B22: As above but frequently moderately mottled and strong, coarse to medium lenticular breaking to fine to medium blocky. Clear to - B23ca: As above with small amounts of concretionary carbonate. Gradual to diffuse to - B24ca or Dca: (frequently present) Occasionally moderately dark-mottled yellow to brown to grey (7.5YR, 10YR, 2.5Y 3/4, 4/2 to 4/6, 5/3 to 5/6); light to medium clay; moderate to strong medium blocky; dry hard to very hard; small amounts of concretionary carbonate. Ferromanganiferous nodules throughout. Depression: Similar morphology but greater depth to carbonate and lower pH.	Burdekin River alluvial plain Low lying flats	Low open woodland to low woodland or occasionally woodland of poplar gum and carbeen with broad leaf tea-tree associated with Tussock grassland of blue grasses, kangaroo grass and black spear grass

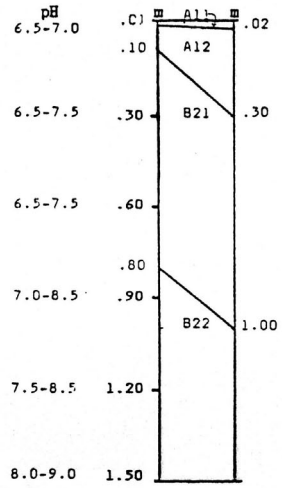
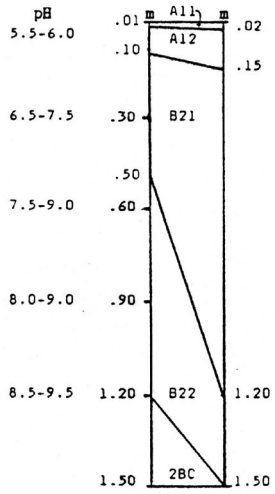
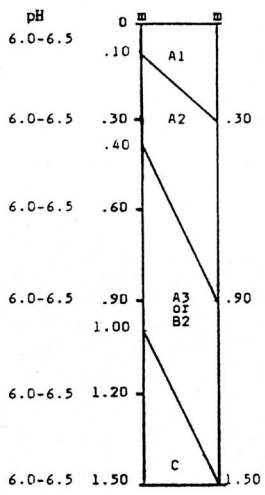
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
2Uge	Ug5.29 Ug5.25 Ug5.28 Ug3.2 Ug5.15 Ug5.24 Ug3.1 Ug5.34 Ug5.35 Ug3.3		Grey and brown clay and black earth, (bleached) grey and brown clay - (bleached) black earth: Weak to moderate gilgai, weakly to moderately cracking. Mound: A11: (occasionally present) Weak, medium to fine granular self-mulch (when absent, surface is hard setting). A12: Moderately brown-mottled dark to grey (10YR, 2.5Y 3/1 to 4/2); light to light medium clay; moderate to strong, medium to fine blocky; dry hard to very hard; occasionally with sporadic bleach. Abrupt to clear to - B21: Moderately brown-mottled dark to grey or brown (10YR, 2.5Y 3/1 to 4/2, 4/3); medium to heavy clay; strong, medium blocky breaking to fine blocky; dry very hard to extremely hard. Gradual to diffuse to - B22: As above but frequently moderately brown-mottled and strong, coarse lenticular breaking to fine blocky. Clear to - B23ca: As above with small to moderate amounts of concretionary carbonate. Gradual to diffuse to - B24ca or Dca: Occasionally moderately dark-mottled brown to yellow or grey (7.5YR, 10YR 4/2 to 4/6, 5/4, 5/6); light to medium clay; moderate to strong, medium to fine blocky; dry hard to very hard; small to moderate amounts of concretionary carbonate. Ferromanganiferous nodules throughout B and D horizons. Depression: Similar morphology but A horizon frequently bleached, greater depth to carbonate and lower pH.	Burdekin River alluvial plain Low lying flats	Low open woodland to low woodland of poplar gum with carbeen and cabbage gum associated with Tussock grassland of blue grasses, black spear grass and kangaroo grass
2Ugg	Ug5.29 Ug5.24 Ug5.28 Ug5.25 Ug3.1 Ug3.3 Ug5.2		Grey clay-(bleached) grey clay - black earth: Moderate to strong gilgai, moderately to strongly cracking. Mound: A11: Weak to moderate, medium to fine granular self-mulch. A12: Frequently moderately brown-mottled grey to dark (10YR 3/1 to 4/2); medium to heavy clay; strong, medium blocky; dry very hard; occasionally with sporadic bleach. Clear to - B21: Frequently weakly to moderately brown-mottled grey to dark or brown (10YR, 2.5Y, 3/2, 4/1, 4/2, 4/3, 5/2); medium to heavy clay; strong, medium blocky; dry extremely hard. Gradual to diffuse to - B22: As above but occasionally weakly to moderately brown-mottled and strong, coarse lenticular breaking to medium blocky. Clear to - B23ca: As above with small to moderate amounts of concretionary carbonate. Gradual to diffuse to - B24ca or Dca: Occasionally moderately dark-mottled yellow-brown to grey (10YR, 2.5Y 4/2 to 5/3); light medium to medium heavy clay; moderate to strong, medium blocky; dry hard to very hard; small to moderate amounts of concretionary carbonate. Ferromanganiferous nodules throughout. Depression: Similar morphology but A and B21 horizons frequently dark.	Burdekin River alluvial plain Low lying flats	Low open woodland to woodland of poplar gum with carbeen and broad leaf tea-tree associated with Tussock grassland of blue grasses and cane grass
2Ugh	Ug5.29 Ug5.28 Ug5.15 Ug5.25 Ug5.35 Ug5.24 Ug5.2		Grey clay - brown clay - black earth: Moderate to strong gilgai, moderately to strongly cracking. Mound: A11: Weak to strong, medium to fine granular self-mulch. A12: Weakly to moderately brown-mottled grey to dark (10YR, 2.5Y 3/1 to 4/2); medium to medium heavy clay; strong medium to fine blocky; dry extremely hard. Clear to - B21: Occasionally weakly to moderately brown-mottled grey to dark or brown (10YR, 2.5Y 3/2, 4/1, 4/2, 4/3); medium to heavy clay; strong medium to fine blocky; dry extremely hard. Gradual to diffuse to - B22ca: Grey to dark (10YR, 2.5Y 3/2, 4/1, 4/2); medium to heavy clay; strong, coarse to medium lenticular breaking to fine blocky; dry extremely hard; small to moderate amounts of concretionary carbonate, occasionally gypsum crystals. Gradual to diffuse to - B23ca or Dca: Occasionally moderately dark-mottled yellow-brown to brown or grey (7.5YR, 10YR 4/2 to 5/4); light medium to medium heavy clay; moderate to strong, medium to fine blocky, dry very hard, small to moderate amounts of concretionary carbonate. Ferromanganiferous nodules throughout B and D horizons. Trace to small amounts of concretionary carbonate may be present from the surface. Depression: Similar morphology but A and B21 horizons frequently dark, greater depth to carbonate and lower pH.	Burdekin River alluvial plain Low lying flats	Tussock grassland of blue grasses, Flinders grass and cane grass with Occasionally isolated trees to low open woodland of carbeen poplar gum and cabbage gum.

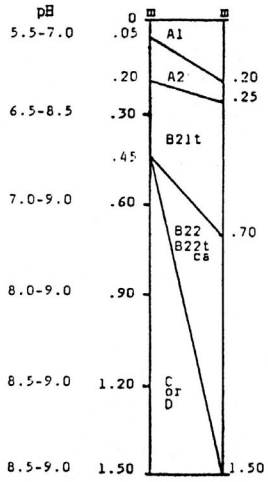
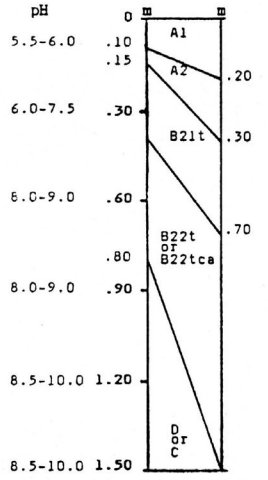
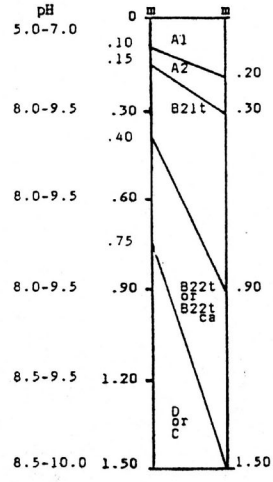
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
2Dba	Db1.43 Db1.33		Brown solodic-solodized solonetz: Occasionally incipient gilgai, hard setting surface. A1: Occasionally moderately yellow-mottled brown (7.5YR, 10YR 3/3 to 4/4); clay loam to fine sandy clay loam; massive to weak, medium blocky to thick platy; dry very hard; frequently with conspicuous or sporadic bleach. Abrupt to - A2: (present when A1 not bleached). As above with sporadic or conspicuous bleach. Abrupt to - B21t: Brown (7.5YR, 10YR 3/3, 4/3 to 4/6); light medium to medium heavy clay; strong, coarse columnar or blocky breaking to medium to fine subangular blocky or prismatic; dry extremely hard. Clear to - B22tca: Brown - yellow brown (7.5YR, 10YR 3/3, 4/3 to 4/6, 5/3, 5/4); light medium to medium clay; strong, medium to fine subangular blocky; dry extremely hard; small amounts of concretionary carbonate. Clear to - Dca: (frequently present) Brown (7.5YR 4/3, 4/4, 5/3 to 5/6); sandy clay to light medium clay; moderate to strong; medium to fine subangular blocky; dry hard; small amounts of concretionary carbonate. Ferromanganiferous nodules throughout B horizons. Depression: Similar morphology but A horizon frequently strongly mottled.	Burdekin River alluvial plain Slightly elevated flats	Low to tall scrubland of false sandalwood and beefwood with cabbage gum, poplar gum and carbeen associated with Open to sparse tussock grassland of blue grasses, black spear grass, purple top Rhodes grass and button grass
2Dbb	Db1.33 Db1.43 Db2.33 Db1.43		Brown and dark solodic-solodized solonetz: Hard setting surface. A1: Occasionally moderately brown-mottled dark to brown (7.5YR, 10YR 3/1 to 4/3); clay loam to fine sandy clay loam; massive to weak, medium blocky to platy; dry hard. Abrupt to - A2: As above with sporadic or conspicuous bleach. Abrupt to clear to - B21t: Occasionally yellow-mottled brown to dark (7.5YR, 10YR, 3/2, 3/3, 4/3 to 4/6); medium clay; strong, coarse columnar or blocky breaking to medium to fine blocky to prismatic; dry extremely hard. Clear to - B22t or B22tca: Brown (7.5YR, 10YR 4/3 to 5/4); medium clay; strong, medium to fine blocky to prismatic; dry extremely hard; trace to small amounts of concretionary carbonate. Clear to - Dca: Brown to yellow-brown (7.5YR, 10YR 4/3 to 4/6, 5/3, 5/4); sandy clay to light medium clay; moderate, medium to fine subangular blocky; dry hard, small amounts of concretionary carbonate. Ferromanganiferous nodules throughout B and D horizons.	Burdekin River alluvial plain Slightly elevated flats	Low open woodland of poplar gum, carbeen and cabbage gum with beefwood and mimosa associated with Tussock grassland of purple top Rhodes grass and black spear grass
2Dbc	Db2.43 Db2.33 Db1.33 Dy3.43 Dd1.43 Dy3.33		Brown, grey and dark solodic-solidized solonetz: Hard setting surface. A1: Moderately brown-mottled dark to grey (10YR 3/1 to 4/2); loam to fine sandy clay loam; massive to weak, medium subangular blocky; dry hard. Abrupt to - A2: As above with sporadic or conspicuous bleach. Abrupt to - B21t: Frequently moderately brown-mottled brown to dark (10YR 3/2 to 4/3); light medium to heavy clay; strong, coarse columnar or blocky breaking to medium to fine blocky to prismatic; dry extremely hard. Clear to - B22t or B22tca: Brown to dark (10YR 3/2 to 4/3); light medium to heavy clay; strong, medium to fine blocky to prismatic; dry extremely hard; trace to small amounts of concretionary carbonate. Clear to gradual to - D or Dca: (occasionally present) Frequently moderately dark-mottled brown to yellow-brown (7.5YR, 10YR 4/3 to 4/6, 5/4 to 6/6); sandy clay to light medium clay; moderate, medium to fine blocky; dry hard; trace to small amounts of concretionary carbonate. Ferromanganiferous nodules throughout B and D horizons.	Burdekin River alluvial plain Slightly elevated flats	Low open woodland to low woodland of poplar gum, carbeen and cabbage gum with Tussock grassland of black spear grass, blue grasses and kangaroo grass

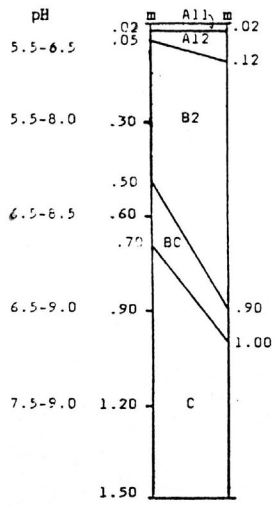
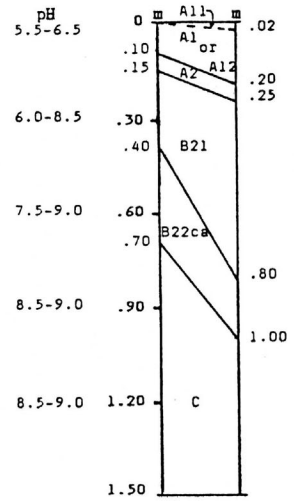
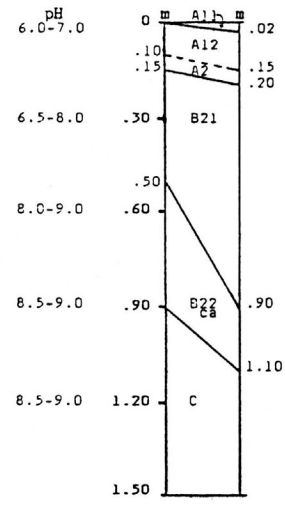
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
2Dbd	Db1.43 Db1.33 Db2.33 Dy3.43 Dd1.33 Dy3.33 Db2.43		Brown, grey and dark solodic-solodized solonetz: Hard setting surface. A1: Moderately brown-mottled dark to brown (10YR, 3/1 to 4/3); loam to fine sandy clay loam; massive to weak, medium subangular blocky; dry hard. Abrupt to - A2: As above with sporadic or conspicuous bleach. Abrupt to - B21t: Occasionally moderately yellow-mottled brown to dark (7.5YR, 10YR 3/2 to 4/4); medium to medium heavy clay; strong, coarse columnar prismatic or blocky breaking to medium to fine blocky to prismatic; dry extremely hard. Clear to gradual to - B22tca: As above but strong, fine to medium blocky to lenticular; dry extremely hard; small amounts of concretionary carbonate. Clear to gradual to - Dca: Frequently moderately dark-mottled brown to yellow-brown (7.5YR, 10YR 4/4, 4/6 to 5/6, 6/4); sandy clay to medium clay; moderate, medium to fine blocky; dry hard; small amounts of concretionary carbonate. Ferromanganiferous nodules throughout B and D horizons.	Burdekin River alluvial plain Slightly elevated flats	Low open woodland to woodland of cabbage gum, carbeen and poplar gum with Tussock grassland of black spear grass, blue grasses and kangaroo grass
2Dbe	Db2.43 Db2.33 Db1.33 Dd1.33 Dy2.33		Brown, dark and grey solodic-solodized solonetz: Hard setting surface. A1: Moderately brown-mottled dark to grey (10YR 3/1 to 4/2); loam to fine sandy clay loam; massive to moderate, medium blocky; dry hard. Abrupt to - A2: As above with sporadic or conspicuous bleach. Abrupt to - B21t: Frequently moderate red to brown-mottled brown to dark (10YR 3/1 to 4/2, 4/3, 4/4); medium to medium heavy clay; strong, coarse columnar, prismatic or blocky breaking to medium to fine blocky; dry extremely hard. Gradual to diffuse to - B22t: As above but frequently whole coloured and strong medium to fine blocky. Clear to - B23t or B23tca: As above with trace to small amounts of concretionary carbonate. Clear to gradual to - Dca: (frequently present) Occasionally moderately dark-mottled yellow-brown to brown (7.5YR, 10YR 4/4 to 5/6, 6/4); light to medium clay; moderate, medium to fine blocky; dry hard; small amounts of concretionary carbonate. Ferromanganiferous nodules throughout B and D horizons.	Burdekin River alluvial plain Slightly elevated flats	Low open woodland of open woodland of poplar gum, cabbage gum and carbeen with beefwood associated with Tussock grassland of black spear grass, blue grasses and kangaroo grass
2Dya	Dy3.33 Dy2.33 Dy2.43 Dy2.33 Db2.33		Grey and brown solodic-solidized solonetz: Occasionally incipient to weak gilgai, hard setting surface. A1: Frequently moderately brown-mottled dark to brown (7.5YR, 10YR 3/1 to 4/2, 4/3); clay loam to fine sandy clay loam; massive to weak, medium to thick platy to fine medium blocky; dry hard; frequently with conspicuous or sporadic bleach. Abrupt to - A2: (present when A1 not bleached) As above with sporadic or conspicuous bleach. Abrupt to - B21t: Frequently moderately brown-mottled grey to brown (10YR, 2.5Y 4/1 to 4/4); medium to medium clay; strong, coarse columnar to prismatic breaking to medium to fine subangular blocky to prismatic; dry extremely hard. Gradual to diffuse to - B22t: As above but whole coloured and strong medium to fine blocky to lenticular. Clear to - B23t or B23tca: Brown to grey (7.5YR, 10YR 4/1 to 4/3, 5/3, 5/4); medium clay; strong, fine medium blocky to lenticular; dry extremely hard; trace to small amounts of concretionary and soft carbonate. Clear to - D or (frequently present) Brown (7.5YR, 10YR 4/3 to 5/4); sandy clay to light medium clay; moderate, medium to fine blocky; dry hard; trace to small amounts of concretionary carbonate. Ferromanganiferous nodules throughout B horizon. Depression when present: Similar morphology	Burdekin River alluvial plain Slightly elevated flats	Low open woodland to woodland of poplar gum, cabbage gum and carbeen with beefwood and broad leaf tea-tree associated with Tussock grassland of blue grasses and kangaroo grass

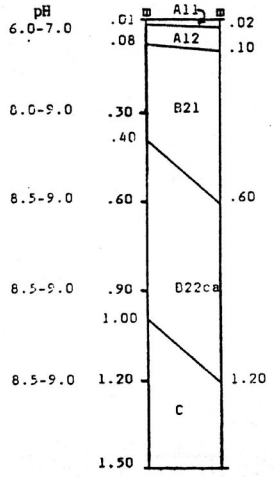
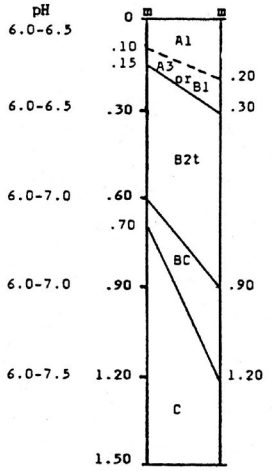
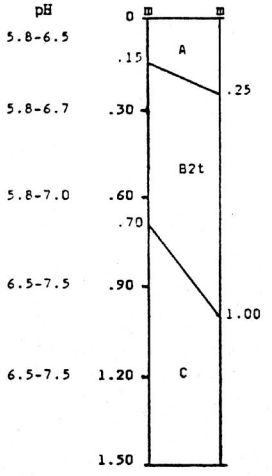
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
2Dyb	Dy3.33 Dy2.33 Dy2.43 Dd1.43		Grey and dark solodic-solodized solonetz: Hard setting surface. A1: Moderately brown-mottled dark to grey or brown (7.5YR, 10YR 3/1 to 4/2, 4/3); loam to fine sandy clay loam; massive to weak, medium subangular blocky to platy; dry slightly hard. Abrupt to - A2: As above with sporadic or conspicuous bleach. Abrupt to - B21t: Frequently moderately brown-mottled grey to dark (10YR, 2.5Y 3/1, 4/1, 4/2); medium to medium heavy clay; strong, coarse columnar to medium prismatic breaking to medium to fine subangular blocky or prismatic; dry extremely hard. Gradual to - B22t or B22tca: Grey to brown or dark (7.5YR, 10YR, 2.5Y 3/1 to 4/2, 4/3, 4/4); medium to medium heavy clay; strong medium to fine subangular blocky to lenticular; dry extremely hard; trace to small amounts of concretionary carbonate. Clear to - Dca: (frequently present) Occasionally moderately dark-mottled brown (7.5YR, 10YR 4/3 to 5/4); light to medium clay; moderate medium to fine subangular blocky; dry hard; small amounts of concretionary carbonate. Ferromanganiferous nodules throughout B horizon. Variations: D horizon red (5YR 4/3 to 5/6). Small amounts of gypsum crystals in B22tca horizon.	Burdekin River alluvial plain Slightly elevated flats	Low open woodland of cabbage gum and poplar gum with beefwood associated with Tussock grassland of black spear grass, blue grasses and purple top Rhodes grass
2Dyc	Dy3.33 Dy3.43 Db2.33		Grey and brown solodic-solodized solonetz: Moderate to strong gilgai, hard setting surface. Mound: A1: Moderately brown-mottled dark to brown (10YR 3/1 to 4/2, 4/3); sandy clay loam to fine sandy clay loam; weak, medium subangular blocky to platy; dry hard. Abrupt to - A2: As above with sporadic or conspicuous bleach. Abrupt to - B21t: Moderately brown-mottled grey to brown (10YR, 2.5Y 4/1 to 4/3, 5/2 to 5/4); medium to medium heavy clay; strong, coarse columnar to prismatic or blocky breaking to medium to fine blocky; dry extremely hard. Gradual to - B22t: As above but whole coloured and strong coarse to medium lenticular breaking to fine blocky. Clear to - B23t or B23tca: As above, with trace to small amounts of concretionary carbonate. Clear to gradual to - B24tca or Dca: Frequently moderately dark-mottled grey to yellow-brown (10YR 4/3, 4/4, 5/2 to 5/6); light to medium clay; moderate to strong, medium to fine blocky; dry hard; small amounts of concretionary carbonate. Ferromanganiferous nodules throughout B and D horizons. Depression: Similar morphology.	Burdekin River alluvial plain Low lying flats	Low open woodland to open woodland of poplar gum and cabbage gum with Tussock grassland of blue grasses, black spear grass, and kangaroo grass
2Ddb	Dd1.33 Dy2.33 Dd1.43		Dark and Grey solodic-solodized solonetz: Hard setting surface. A: Moderately brown-mottled dark to brown (7.5YR, 10YR 3/2, 4/2, 4/3); loam fine sandy to fine sandy clay loam; massive to weak, medium subangular blocky to platy; dry very hard; conspicuous or sporadic bleach throughout or near base. Abrupt to - B21t: Dark to grey (10YR, 2.5Y 3/1 to 4/2); medium to medium heavy clay; strong, coarse columnar or prismatic breaking to medium to fine subangular blocky or prismatic; dry extremely hard. Clear to - B22tca: Dark to brown (10YR, 2.5Y 3/1 to 4/2, 4/3, 4/4); medium to medium heavy clay; strong, medium to fine subangular blocky; dry extremely hard; small amounts of concretionary carbonate. Clear to - Dca: Brown (7.5YR, 10YR 4/3 to 5/4); light to medium clay; moderate to strong, medium to fine blocky to prismatic, dry very hard, small amounts of concretionary carbonate. Ferromanganiferous nodules throughout B and D horizons. Variation: Trace to small amounts of gypsum crystals in B22tca horizon.	Burdekin River alluvial plain Slightly elevated flats	Low open woodland of beefwood and cabbage gum. or Low to tall scrubland of false sandalwood and beefwood with Open to sparse tussock grassland of black spear grass, blue grasses, purple top Rhodes grass and kangaroo grass

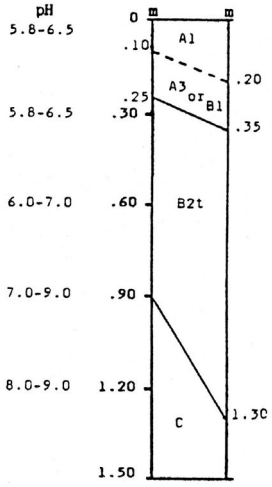
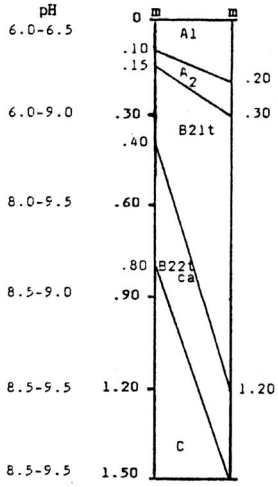
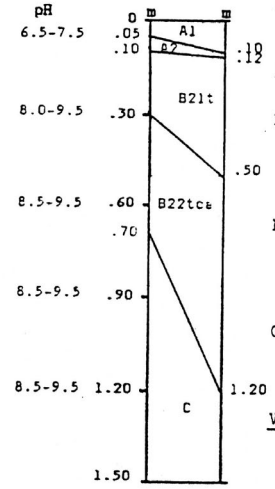
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
3Uga	Ug5.16 Ug5.1 Ug5.24 Ug5.28		Black earth - grey clay: Weak to strong gilgai, strongly cracking. Mound: A11: Moderate, medium granular self-mulch. A12: Dark (7.5YR, 10YR 1.7/1, 2/1, 2/2, 3/1); medium to medium heavy clay; moderate to strong, medium to fine subangular blocky to blocky; dry very hard. Clear to - B21: Dark to grey (10YR 1.7/1, 2/1, 3/1, 4/1); medium heavy to heavy clay; strong, medium blocky to subangular blocky; dry extremely hard; frequently trace to small amounts of concretionary carbonate. Clear to gradual to - B22 or B22ca: Dark to grey (10YR, 2.5Y 2/1, 3/1, 3/2, 4/1); heavy clay; strong, coarse lenticular breaking to medium to fine lenticular to subangular blocky; dry extremely hard; trace to small amounts of concretionary carbonate. Gradual to - B23 or B23ca: As above but grey to dark (10YR, 2.5Y 3/1, 4/2 to 6/2). Ferromanganiferous nodules often present throughout. Concretionary carbonate may be present on the surface. Depression: Similar morphology but greater depth to carbonate. Variant: 3Uga8. Profile has small amounts of rounded and subrounded pebbles throughout.	Local alluvial plain Plain	Tussock grassland of cane grass and blue grasses
3Ugd	Ug5.16 Ug5.24 Ug5.28		Black earth-grey clay: Weak to strong gilgai, strongly cracking. Mound: A11: Moderate to strong, coarse granular self-mulch. A12: Dark (7.5YR, 10YR, 1.7/1, 2/1, 2/2, 3/1); medium to medium heavy clay; moderate to strong, medium subangular blocky to blocky; dry very hard. Clear to - B21: Dark to grey (7.5YR, 10YR, 2.5Y 2/1, 3/1, 3/2, 4/1); heavy clay; strong, medium blocky to subangular blocky to lenticular; dry extremely hard. Clear to gradual to - B22 or B22ca: Grey (10YR, 2.5Y 4/1 to 5/2, 6/1); heavy clay; strong, coarse to medium lenticular breaking to fine blocky to subangular blocky; dry extremely hard; trace to small amounts of concretionary carbonate. Ferromanganiferous nodules throughout. Depression: Similar morphology.	Local alluvial plain Plain	Tussock grassland of cane grass and blue grasses with brown top and Flinders grass
3Uge	Ug5.17		Black earth: Weak to moderate gilgai, moderately to strongly cracking. Mound: A11: Weak medium to fine granular self-mulch. A12: Frequently moderately brown-mottled dark (7.5YR, 10YR, 2.5Y 2/1, 2/2, 3/1, 3/2); medium clay; strong, medium blocky to subangular blocky breaking to very fine subangular blocky to blocky; dry extremely hard. Clear to - B21: Dark (10YR, 2.5Y 2/1, 2/2, 3/1, 3/2); medium heavy clay; strong, medium lenticular breaking to fine subangular blocky to blocky; dry extremely hard. Abrupt to clear to - Dca: Brown (7.5YR, 10YR 4/3, 4/4, 4/6); light to medium clay; weak to moderate, medium subangular blocky breaking to fine blocky; dry extremely hard; small amounts of concretionary carbonate. Ferromanganiferous veins and nodules throughout. Depression: Similar morphology.	Local alluvial plain Plain	Tussock grassland of cane grass and blue grasses

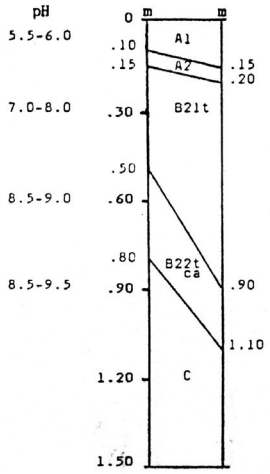
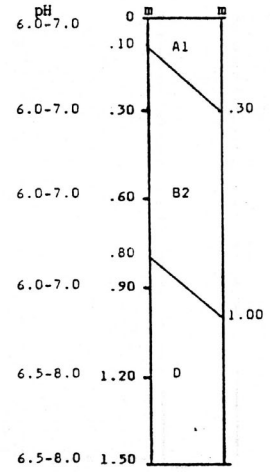
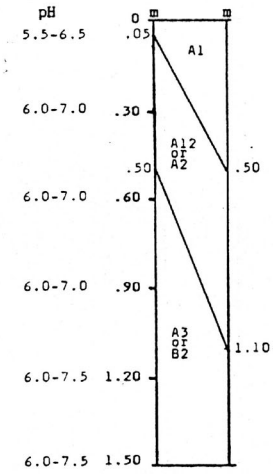
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
3Ugf	Ug5.15 Ug5.16 Ug5.1		<u>Black earth</u>: Gilgai absent, moderately cracking. A11: Weak to moderate granular self-mulch. A12: Dark (5YR, 7.5YR, 10YR 1.7/1, 2/1) silty clay; strong, medium to fine subangular blocky; dry very hard. Clear to - B21: Dark (5YR, 7.5YR, 10YR, 2.5Y 2/1, 2/2, 3/1); medium clay; strong, medium to fine subangular blocky to blocky; dry extremely hard. Gradual to - B22: Dark to yellow-brown (10YR, 2.5Y 2/1 to 4/1, 3/2, 4/3, 5/4); medium to medium heavy clay; strong, medium lenticular to blocky to subangular blocky; dry very hard. Ferromanganiferous veins and nodules below 0.10 - 0.30m. Concretionary carbonate below 0.40 - 0.80m. Weakly structured D horizon below 1.00m. <u>Variation</u>: (Ug5.17)	Local alluvial plain Plain	Low open woodland of carbeen and poplar gum with grey bloodwood occasionally associated with Tussock grassland of blue grasses, Rhodes grass, black spear grass and cane grass
3Ugk	Ug5.2 Ug5.28 Ug5.24		<u>Grey clay</u>: Moderate to strong gilgai, moderately to strongly cracking. <u>Mound</u>: A11: Weak to moderate, medium to fine granular self-mulch. A12: Weakly brown-mottled grey (10YR, 2.5Y 4/1, 4/2); light medium to medium clay; strong, fine subangular blocky to blocky; dry very hard. Clear to - B21: Grey (10YR, 2.5Y 4/1, 4/2); medium clay; strong, meduim to fine lenticular; dry very hard; Gradual to - B22: Grey to yellow-grey (10YR, 2.5Y 4/2 to 5/3, 5/4); medium to medium heavy clay; strong, medium to fine lenticular; dry very hard. Gradual to diffuse to - 2BC: Yellow-brown to yellow (10YR, 2.5Y 5/4 to 6/6); light medium to medium clay; strong medium lenticular to blocky; dry hard. Ferromanganiferous nodules grequently throughout. Trace to small amounts of concretionary carbonate frequently present below 0.70m. Subrounded and rounded pebbles present in upper profile and occasionally throughout. <u>Depression</u>: Similar morphology.	Local alluvial plain Plain margins bordering other landscape units	Low open woodland of poplar gum, carbeen with broad leaf tea-tree associated with Tussock grassland of cane grass and blue grasses with paragrass associated.
4Ucc	Uc2.21 Uc2.22 Uc2.12		<u>Bleached uniform sands</u>: Loose or hard setting surface. A1: Dark to brown (7.5YR, 10YR 3/2 to 4/3); coarse sand to sandy loam; massive; dry loose to slightly hard. Clear to - A2: Occasionally moderately brown-mottled grey to light yellow-brown (7.5YR, 10YR 6/2 to 6/4, 7/3); coarse sand to sandy loam; massive; dry loose to soft; conspicuous or sporadic bleach. Clear to - A3 or B2: Occasionally moderately brown-mottled grey to yellow-brown (7.5YR, 10YR 6/2 to 6/6); coarse sand to sandy loam; massive; dry loose to soft. Gradual to - C: Coarse sand and decomposed granite or hard rock. Ferromanganiferous nodules throughout. <u>Variant</u>: 4Ucc1 - Hard rock below 0.50m.	Gently undulating rises on acid intrusive rocks, pediments and prior streams Pediments	Woodland to low woodland of cabbage gum, poplar gum and grey bloodwood, with quinine bush and broad leaf tea-tree associated with Open tussock grassland of black spear grass and giant spear grass

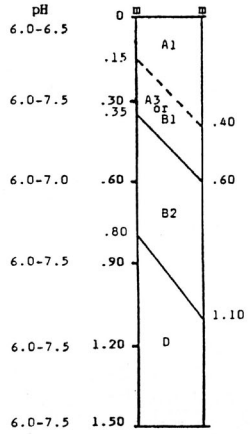
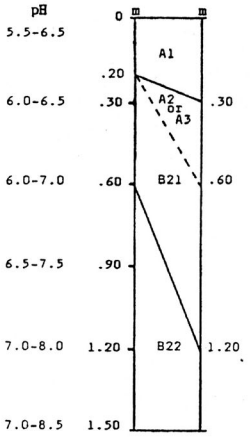
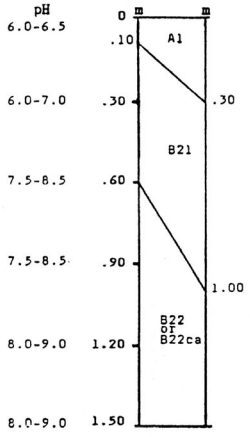
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
4Dba	Db1.33 Db1.43 Db2.33 Db2.43		Brown solodic-solodized solonetz: Hard setting surface. A1: Brown (10YR 3/3 to 4/4); sandy loam to sandy clay loam; massive to weak, medium blocky; dry slightly hard. Abrupt to - A2: As above with sporadic or conspicuous bleach. Abrupt to - B21t: Occasionally moderately grey-mottled brown (7.5YR, 10YR 3/3 to 4/6); light medium to medium clay; strong, coarse columnar or prismatic breaking to medium to fine blocky to prismatic; dry extremely hard. Clear to - B22tca: Moderately grey-mottled brown to yellow-brown (10YR 3/3 to 4/6, 5/3, 5/4); medium to medium heavy clay; strong, medium to fine blocky to prismatic; dry extremely hard; small amounts of concretionary carbonate. Gradual to - C or D: Gravelly mixed colluvia or coarse sand. Ferromanganiferous nodules throughout B horizons.	Gently undulating rises on acid intrusives rocks, pediments and prior streams Pediments and prior streams	Open woodland of poplar gum, grey ironbark, red bloodwood and cabbage gum with beefwood associated with Open tussock grassland of giant spear grass, black spear grass, wire grass and blue grasses
4Dyg	Dy2.43 Dy2.33 Dy3.43 Dy1.43 Dy2.43		Grey, yellow and brown solodic-solodized solonetz: Hard setting surface. A1: Dark to grey to yellow-brown (7.5YR, 10YR 2/1 to 3/2, 4/2 to 5/4); gravelly clayey sand to clay loam; massive to weak medium blocky; dry slightly hard; occasionally conspicuously bleached. Abrupt to - A2: As above with sporadic or conspicuous bleach. Abrupt to - B21t: Occasionally strongly yellow-mottled grey to yellow or brown (10YR, 2.5Y 4/2 to 5/6); light medium to medium clay; strong, coarse columnar or prismatic breaking to medium to fine blocky or prismatic; dry extremely hard. Clear to - B22t or B22tca: Frequently strongly yellow-mottled grey to yellow (10YR, 2.5Y 5/1 to 6/4, 6/6); light medium to medium clay; strong, medium to fine blocky; dry extremely hard; trace to moderate amounts of concretionary or soft carbonate. Gradual to - D or C: Strongly yellow-mottled grey to yellow-brown (10YR 5/2 to 6/3); gritty, sandy or light clay or decomposing rock. Trace to large amounts of ferromanganiferous concretions throughout B horizons. Variations: A2 absent or not bleached (Dy2.13 or Dy2.23). Solum has neutral SRT, underlain by alkaline silica cemented pan below 0.80m (Dy3.42).	Gently undulating rises on acid intrusive rocks, pediments and prior streams Pediments and prior streams	Low open woodland to woodland of cabbage gum grey ironbark, poplar gum and broad leaf tea-tree with bulloak and false sandalwood associated with Tussock to open tussock grassland of black spear grass, kangaroo and blue grasses with wire grass and purple top Rhodes grass associated
4Dyh	Dy2.43 Dy2.33 Dy3.43 Dd1.43 Dd1.33 Db1.43 Db2.43		Grey, dark and brown solodic-solidized solonetz: Hard setting surface. A1: Dark to grey (10YR, 2.5Y 3/2 to 4/2); light sandy clay loam to fine sandy clay loam, massive to weak thick platy, dry hard. Abrupt to - A2: As above with conspicuous or sporadic bleach. Abrupt to - B21t: Frequently moderately brown-mottled grey to yellow-brown or dark (10YR, 2.5Y 3/2 to 5/3); light medium to medium clay; strong, coarse columnar or prismatic breaking to medium to fine blocky; dry extremely hard. Clear to gradual to - B22t or B22tca: Grey to yellow-brown (10YR, 2.5Y 4/2 to 5/4); light medium to medium clay; strong, medium to fine blocky; dry extremely hard; trace to small amounts of concretionary and soft carbonate. Gradual to - D or C: Grey to yellow-brown (10YR, 2.5Y 5/1 to 6/3); sandy clay or light clay with small pebbles or decomposing rock. Ferromanganiferous nodules throughout B horizons. Variations: B21 and B22 horizons have textures of sandy clay or light clay with small pebbles. Only upper 0.10m of B21t horizon mottled.	Gently undulating rises on acid intrusive rocks, pediments and prior streams Pediments and prior streams	Low open woodland to woodland of carbeen, gum and broad leaf tea-tree with beefwood, grey ironbark and false sandalwood associated with Open tussock grassland of purple top Rhodes grass, love grass, wire grass and blue grasses

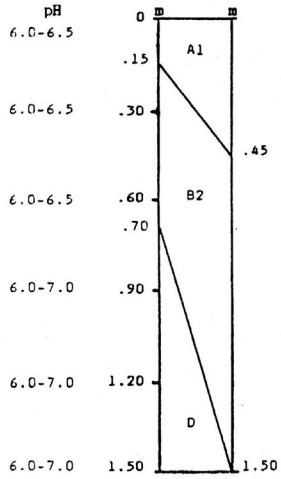
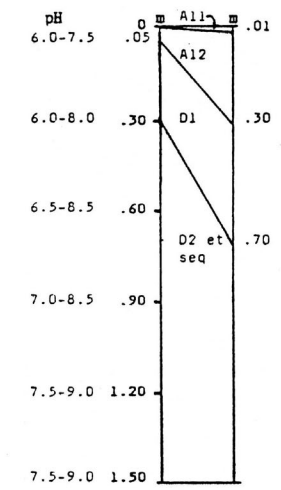
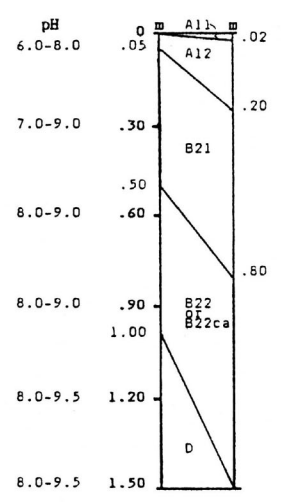
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
5Uga	Ug5.12 Ug5.14 Ug5.22		Black earth: Moderately to strongly cracking. A11: Moderate to strong medium to fine granular self-mulch. A12: Dark (7.5YR,10YR 3/1, 3/2); medium to medium heavy clay; strong, medium to fine blocky; dry hard. Clear to - B2: Dark to grey (7.5YR, 10YR 3/1, 3/2, 4/1); medium to heavy clay; strong, medium to fine lenticular to blocky; dry extremely hard. Gradual to - BC: Grey (10YR, 2.5Y 4/1, 4/2); light medium to medium clay; moderate to strong, medium to fine subangular blocky to lenticular; dry hard. Gradual to - C: Decomposing rock. Variations: Trace to small amounts of concretionary carbonate may be present in lower B2 horizon or BC horizon. Incipient gilgai may be present.	Gently undulating rises on an intrusive rock complex No fixed slope position	Isolated trees to low open woodland of cabbage gum, grey ironbark and poplar gum with carbeen associated with Tussock grassland of blue grasses, cane grass and chloris spp. Occasionally only grassland present.
5Ugb	Ug5.22 Ug5.14 Ug3.2 Ug3.1		Grey clay - black earth: Weakly cracking. A11: (frequently present) Weak, medium to fine granular self-mulch. (when absent surface is hard setting). A1 or A12: Grey to dark (7.5YR, 10YR 3/1, 3/2, 4/1); light to light medium clay; moderate, fine subangular blocky to blocky; dry hard. Clear to - A2: (occasionally present) As above with sporadic bleach. Abrupt to clear to - B21: Occasionally moderately yellow to brown-mottled grey to dark (7.5YR, 10YR, 2.5Y 3/1 to 4/2); medium clay; strong, medium to fine subangular blocky to blocky; dry hard. Clear to - B22ca: Grey to yellow-brown to yellow-grey (10YR, 2.5Y 4/1, 4/2, 5/2, 5/4); medium clay; strong medium to fine blocky to lenticular; dry hard, small amounts of concretionary carbonate. Gradual to diffuse to - C: Decomposing rock. Ferromanganiferous nodules throughout B horizons.	Gently undulating rises on an intrusive rock complex No fixed slope position	Isolated trees to low open woodland of cabbage gum and poplar gum with grey ironbark and grey and red bloodwood associated with Tussock grassland of black spear grass, blue grasses and cane grass
5Ugc	Ug5.14 Ug3.1 Ug5.13		Black earth: Linear gilgai complex. Weakly to moderately cracking. Depression associated with 5Ugd and 5Dyf: A11: (frequently present) Weak to moderate, medium to fine granular self-mulch (when absent surface is hard setting). A12: Dark (10YR 2/1 to 3/1); light to light medium clay; moderate to strong, medium to fine blocky; dry hard. Abrupt to clear to - A2: (occasionally present) As above but with sporadic bleach. Abrupt to clear to - B21: Dark (7.5YR, 10YR 2/1 to 3/1); medium clay; strong, medium blocky to lenticular; dry very hard. Clear to - B22ca: Grey to brown (10YR 4/2 to 4/4, 5/4); medium clay; strong, medium to fine lenticular; dry very hard, small amounts of concretionary and soft carbonate. Gradual to - C: Decomposing rock. Ferromanganiferous nodules throughout B horizon. Subangular pebbles may be present throughout profile. Variants: A horizon, clay loam tecture with sporadically bleached A2 horizon (Dd1.33). Surface non-cracking (Uf6.32, Uf3). Note: 5Ugc occupies from 15-40% of the complex 5Dyf-5Ugc.	Gently undulating rises on an intrusive rock complex Mid to lower slopes	Tussock grassland of black spear grass, giant spear grass and cane grass with blue grasses, kangaroo grass and panicum spp. associated

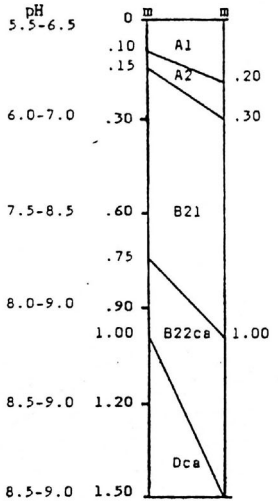
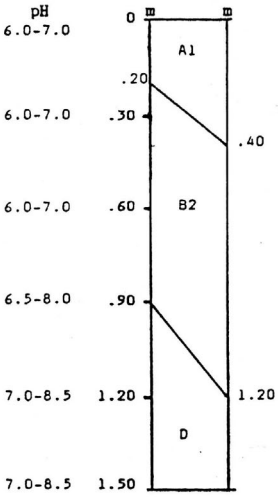
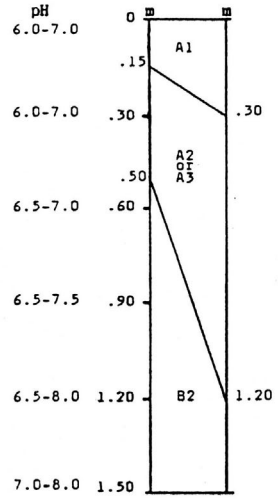
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
5Ugd	Ug5.22 Ug5.26 Ug5.27 Ug5.23		Grey clay: Linear gilgai complex. Weakly to moderately cracking. Mound associated with 5 Ugc and 5Dyf: A11: Weak to moderate, medium to fine granular self-mulch. A12: Grey (10YR, 2.5Y 4/1, 4/2); light to light medium clay; strong, medium to fine granular to blocky, dry hard. Clear to - B21: Grey (10YR, 2.5Y 4/2); medium clay; strong, medium blocky to fine prismatic, dry very hard. Clear to - B22ca: Grey to brown (10YR, 2.5Y 4/2, 4/3, 5/3); medium clay; strong, medium to fine lenticular; dry extremely hard; small to moderate amounts of concretionary and soft carbonate. Gradual to - C: Decomposing rock. Ferromanganiferous nodules throughout B horizon. Subrounded and subangular pebbles may be present on surface and throughout profile. Trace to small amounts of concretionary carbonate on surface and throughout profile, usually increasing at depth. Note: 5Ugd usually occupies 10-20% of complex 5Dyf-5Ugc, but may be absent.	Gently undulating rises on an intrusive rock complex Mid to lower slopes	Open tussock grassland of black spear grass, giant spear grass and blue grasses with panicum spp. associated
5Dra	Dr2.12 Dr2.11 Gn3.12 Dr3.12 Gn3.72 Gn3.11		Non-calcic brown soil: Hard setting surface. A1: Dark to brown (7.5YR, 10YR 3/1 to 3/4, 4/1, 4/2); sandy clay loam to fine sandy clay loam; weak to moderate, medium to fine blocky; dry hard. Abrupt to clear to - A3 or B1: (occasionally present) Dark to brown (7.5YR 3/1 to 3/3); light clay; moderate to strong, medium to fine blocky; dry hard. Clear to gradual to - B2t: Occasionally moderately yellow-mottled, red to red-brown (2.5YR, 5YR 3/3 to 3/6, 4/3 to 4/8, 5/6); light medium to medium clay; strong medium to fine blocky to fine prismatic; dry hard. Clear to gradual to - BC: Red to brown (2.5YR, 5YR, 7.5YR 4/6 to 4/8, 5/3 to 5/6); light to medium clay; massive to weak, fine to medium blocky, dry hard. Gradual to - C: Decomposing rock. Ferromanganiferous nodules throughout B and BC horizons. Variants: 5Dra3 - A horizon, light clay texture (PPF Uf6.31). 5Dra5 - Frequently moderately red-mottled yellow (10YR, 2.5Y 4/6 to 6/6, 5/4); B22t or BC horizons below 0.50m. 5Dra1 - C horizon present by 0.50m.	Gently undulating rises on an intrusive rock complex Crests, upper and mid slopes	Low open woodland to low woodland of grey ironbark and red bloodwood with poplar gum and grey bloodwood associated with Tussock grassland of black spear grass, giant spear grass, kangaroo grass and blue grasses
5Dya	Dy2.12 Dy2.11 Dy3.12		Hard pedal yellow duplex soil: Hard setting surface. A: Dark to brown (7.5YR, 10YR 3/1 to 3/3); sandy clay loam to fine sandy clay loam; massive to weak, medium to fine blocky; dry hard. Abrupt to clear to - B2t: Occasionally moderately red-mottled yellow -brown (7.5YR, 10YR 5/4 to 5/8, 6/6); light medium to medium clay; strong, medium to fine blocky; dry hard. Gradual to - C: Decomposing rock. Ferromanganiferous nodules and veins through -out B horizon.	Gently undulating rises on an intrusive rock complex Upper and mid slopes	Low open woodland to low woodland of poplar gum, red bloodwood and grey ironbark with carbeen and grey bloodwood associated with Tussock grassland of black spear grass, giant spear grass and kangaroo grass

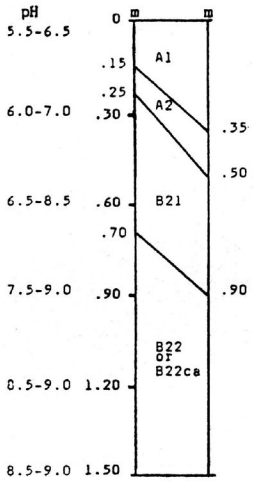
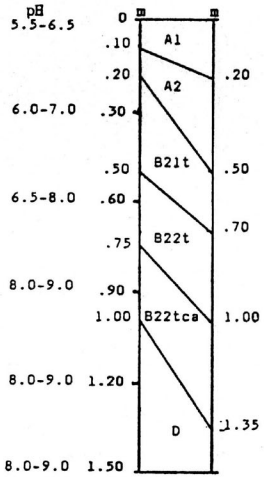
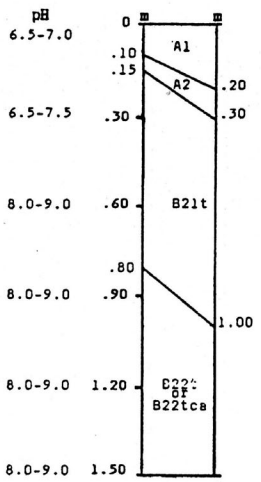
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
5Dyb	Dy2.13 Dy3.13 Gn3.72 Gn3.23 Dy2.12		<u>Hard pedal yellow duplex soil</u>: Hard setting surface. A1: Dark to brown (7.5YR, 10YR 2/2, 3/1 to 3/3, 4/1); clay loam to fine sandy clay loam; massive to weak, medium to fine blocky to granular; dry slightly hard to hard. Clear to - A3 or B1: (occasionally present) Occasionally moderately red to brown-mottled dark to grey (7.5YR, 10YR 3/1 to 4/2); light clay; moderate to strong, medium to fine medium blocky to fine prismatic; dry slightly hard to hard. Gradual to - B2t: Occasionally moderately red to brown-mottled yellow to brown (7.5YR, 10YR 4/4 to 6/6, 5/3); light medium to medium clay; strong, medium to fine lenticular to prismatic to blocky; dry hard. Gradual to - C: Decomposing rock. Ferromanganiferous nodules throughout B horizons. <u>Variation</u>: Trace to moderate amounts of carbonate below 0.70m. B3 horizons may be present with textures of medium to medium heavy clay. <u>Note</u>: Profiles with neutral soil reaction trend have alkaline C horizons.	Gently undulating rises on an intrusive rock complex Mid to lower slopes	Low open to low woodland of poplar gum, cabbage gum and grey bloodwood with scattered beefwood, red bloodwood and grey ironbark associated with Tussock grassland of black spear grass, giant spear grass, kangaroo grass and blue grasses
5Dyc	Dy2.43 Dy2.33 Dy3.33 Dy3.43		<u>Grey solodic-solodized solonetz</u>: Hard setting surface. A1: Occasionally weakly to moderately brown-mottled dark to brown (7.5YR, 10YR 2/1 to 4/3); sandy clay loam to fine sandy clay loam; massive ot weak, thick platy to fine blocky; dry hard. Abrupt to clear to - A2: As above with conspicuous or sporadic bleach. Abrupt to - B21t: Occasionally moderately yellow to brown-mottled grey (10YR, 2.5Y 4/1 4/2); medium to medium heavy clay; strong, coarse to medium columnar to prismatic breaking to medium to fine blocky or prismatic; dry hard to extremely hard. Clear to - B22tca: Grey to brown to yellow-grey (10YR, 2.5Y 4/1 to 4/4, 5/3 to 5/6); medium to medium heavy clay; strong, medium to fine blocky to lenticular; dry hard to extremely hard; small to moderate amounts of concretionary and soft carbonate. Gradual to - C: Decomposing rock or colluvia. Ferromanganiferous nodules throughout B horizon. <u>Variations</u>: Depth of A horizon to 0.55m. B21t horizons dark, or brown to yellow grey (10YR, 2.5Y 3/1, 4/3, 5/3, 5/4).	Gently undulating rises on an intrusive rock complex Lower slopes	Low open woodland of cabbage gum, poplar gum and beefwood with carbeen associated with Tussock to open tussock grassland of black spear grass, Rhodes grass and blue grasses with wire grass associated
5Dyd	Dy2.43 Dy2.33 Db1.43		<u>Grey solodic-solodized solonetz</u>: Hard setting surface. A1: Dark to grey (10YR 3/2 to 4/2); sandy clay loam to fine sandy clay loam; massive to weak, subangular blocky; dry hard. Abrupt to - A2: As above with conspicuous or sporadic bleach. Abrupt to - B21t: Grey to yellow-brown (10YR, 2.5Y 4/2 to 4/4, 5/3, 5/4); light medium to medium clay; strong, coarse columnar to prismatic breaking to medium to fine blocky or prismatic; dry hard to extremely hard. Clear to - B22tca: Grey to yellow-brown (10YR, 2.5Y 4/2 to 5/4); light medium to medium clay; strong, medium to fine lenticular to blocky; dry hard to extremely hard; small to moderate amounts of concretionary and soft carbonate. Gradual to - C: Decomposing rock or colluvia. Ferromanganiferous nodules throughout B Horizons. <u>Variation:</u> B2 horizons may be mottled (Dy3.33).	Gently undulating rises on an intrusive rock complex Lower slopes	Low open woodland of cabbage gum and poplar gum with false sandalwood and beefwood associated. Tall shrubland to tall open shrubland of false sandalwood also occurs with Open tussock grassland of black spear grass Rhodes grass and blue grasses

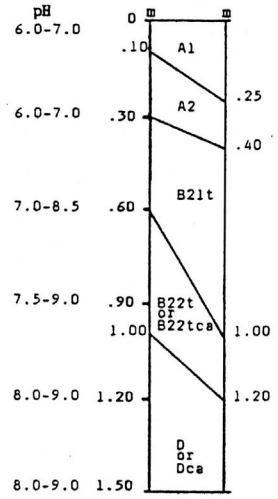
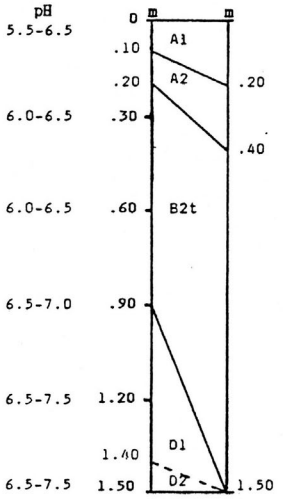
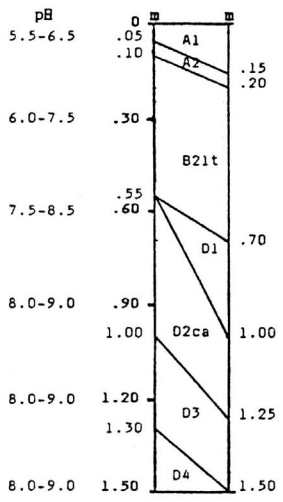
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
5Dyf	Dy2.43 Dy2.33		<u>Grey solodic-solodized solonetz</u>: Linear gilgai complex. Hard setting surface. <u>Shelf associated with 5Ugc and 5Ugd</u>: A1: Occasionally brown-mottled grey (10YR, 2.5Y 4/1 to 4/2); clay loam, massive to weak medium blocky, dry slightly hard to hard. Abrupt to - A2: As above with conspicuous or sporadic bleach. Abrupt to - B21t: Grey (10YR, 2.5Y 4/1, 4/2); light medium to medium clay, strong coarse columnar or prismatic breaking to medium to fine blocky to prismatic, dry extremely hard, often trace to small amounts of concretionary carbonate. Clear to gradual to - B22tca: Grey to brown (10YR, 2.5Y 4/2, 4/3); light medium to medium clay, strong medium to fine blocky to lenticular, dry extremely hard, small to moderate amounts of concretionary and soft carbaonte. Gradual to - C: Decomposing rock. Ferromanganiferous nodules throughout B horizon. <u>Variation:</u> A horizon, light clay (Uf6.33). <u>Note</u>: 5Dyf occupies 50-70% of complex 5Dyf-5Ugc.	Gently undulating rises on an intrusive rock complex Mid to lower slopes	Open woodland to low open woodland cabbage gum and poplar gum with red bloodwood associated with Open tussock grassland of black spear grass, blue grasses, brown top, kangaroo grass and Rhodes grass.
6Uca	Uc5.11 Uc5.21 Uc5.23		<u>Brownish sand and earthy sand</u>: Hard setting surface. A1: Dark (10YR 3/1, 3/2); coarse sand to sandy loam; massive to single grain; dry loose to soft. Gradual to diffuse to - B2: Brown to yellow-brown (7.5YR, 10YR 4/3, 4/6, 5/4, 6/4, 5/6); coarse sand to sandy loam; massive to single grain; dry soft to slightly hard. Gradual to diffuse to - D: Mottled coarse sand with seasonal water table.	Miscellaneous alluvial landforms Prior streams, levees, flood-outs and fans	Low open to low woodland of pandanus, broad leaf tea-tree and grey bloodwood with cocky apple and poplar gum associated with Tussock grassland of giant spear grass and black spear grass
6Ucc	Uc4.24 Uc4.22 Uc4.21 Uc4 Uc5.21 Uc5.23 Uc5.11 Gn2.45 Gn2.82		<u>Pale earthy and weakly structured sand</u>: Loose to hard setting surface. A1: Grey to dark or brown (7.5YR, 10YR, 3/1, 3/2, 4/2 to 4/4); sand to fine sandy loam; single grain to weak medium blocky; dry loose to soft. Gradual to diffuse to - A12 or A2: As above but brown to yellow (7.5YR, 10YR 3/4 to 4/6, 5/3 to 5/6). Gradual to diffuse to - A3 or B2: Brown to yellow (7.5YR, 10YR 3/3 to 5/6, 6/6, 7/6); sand to sandy clay loam single grain to weak medium blocky, dry loose to soft. <u>Variation:</u> A3 or B2 horizon weakly mottled. D horizon of moderately brown-mottled grey to yellow-brown (10YR 4/2 to 5/5); sandy clay below 1.10m Maybe underlain by hard rock at 1.20m. <u>Note</u>: Fine sand and medium sand is common on Burdekin River levee. Coarse sand textures usually associated with creeks.	Miscellaneous alluvial landforms Levees and fans flood-outs	Open woodland to open forest of poplar gum, carbeen, grey bloodwood and Burdekin plum with broad leaf tea-tree, cocky apple, pandanus, prickly pine and quinine bush associated with Tussock grassland of giant spear grass, black spear grass and brown sorghum with golden beard grass and blue grasses assocated.

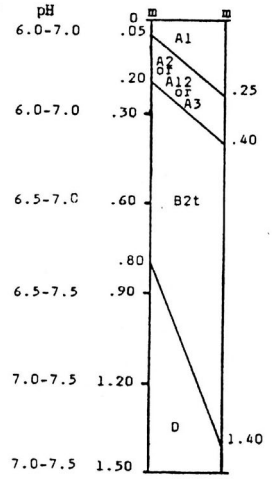
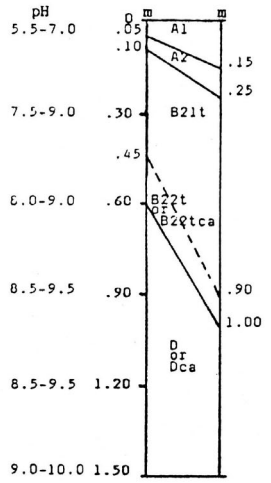
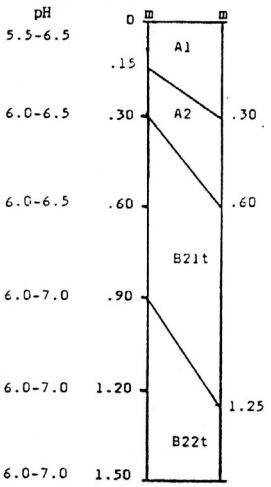
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
6Uma	UM5.52 Gn2.22 Gn2.41 Uc5.22 Uc5.21		Earthy loam, yellow and brown massive earth and earthy sand: Loose to hard setting surface. A1: Dark to brown (7.5YR, 10YR 3/1 to 4/2, 4/3); sandy loam to fine sandy clay loam; massive to weak, medium to coarse blocky; dry slightly hard. Gradual to diffuse to - A3 or B1: (occasionally present) Brown (7.5YR, 4/3, 5/3, 5/4); sandy loam to fine sandy clay loam; massive to weak, medium blocky; dry slightly hard. Gradual to diffuse to - B2: Brown to yellow (7.5YR, 10YR 4/3 to 4/6, 5/3 to 5/6, 6/4 to 6/6); fine sandy loam to clay loam; massive to weak, fine to medium blocky; dry hard. Clear to gradual to - D: Brown (7.5YR 4/3 to 4/6, 5/4 to 6/6); sandy loam to sandy clay loam; massive to weak, medium blocky; dry slightly hard. Variant: 6Uma2 - D horizons of clay loam to medium clay below 0.45 m.	Miscellaneous alluvial landforms Levees	Woodland to low open woodland of carbeen, poplar gum and grey bloodwood with batswing coral, cocky apple, Burdekin plum and Leichhardt tree associated with Tussock grassland of black spear grass, giant spear grass and brown sorghum
6Umb	Um4.42 Um4.4 Um5.52 Um6.31 Uf4.42 Gn3.41		Pale, friable and earthy loam and non-cracking clay: Hard setting surface. A1: Occasionally moderately brown-mottled dark to grey (7.5YR, 10YR 2/2, 3/1 to 4/2); loam fine sandy to sandy clay; weak to moderate, medium to fine blocky to prismatic; dry hard. Gradual to diffuse to - A2 or A3: (Frequently present): As above but brown to yellow-brown (7.5YR, 10YR 4/3 to 5/4). Gradual to diffuse to - B21: Brown to dark (7.5YR, 10YR 3/2 to 3/4, 4/3, 4/4); clay loam to light clay; weak to moderate, medium to fine blocky; dry hard. Gradual to diffuse to - B22: As above but yellow-brown to yellow (7.5YR, 10YR 5/3 to 5/6). Variant: 6Umb2 - D horizons of fine sandy clay loam to medium clay below 0.55 m and B21 may be grey (7.5YR 4/1, 4/2) (Gn3.91).	Miscellaneous alluvial landforms Levees and back plains	Woodland of poplar gum, grey bloodwood and carbeen with cocky apple associated with Tussock grassland of brown sorghum, black spear grass and giant spear grass
6Ufa	Uf6.32		Non-cracking friable clay: Hard setting surface. A1: Brown to dark (7.5YR, 10YR 2/1, 3/3, 3/4); fine sandy light clay to coarse sandy clay; weak, fine subangular blocky to blocky; dry hard. Abrupt to clear to - B21: Dark (5YR, 10YR 1.7/1, to 3/2); light medium to medium clay; strong, medium blocky to subangular blocky to fine prismatic; dry very hard. Clear to - B22 or B22ca: Occasionally moderately brown-mottled dark to brown (5YR, 10YR 2/1, 3/2, 4/6); light medium to medium clay; strong, medium subangular blocky to fine lenticular; dry very hard, trace to small amounts of concretionary and soft carbonate. Variations: A2 horizon bleached (Uf3, Uf2). D horizon of sandy clay loam to clay loam below 0.60 m.	Miscellaneous alluvial landforms Flood-outs, fans and levees	Low open woodland of carbeen, poplar gum and cabbage gum with beefwood and cocky apple associated with Tussock grassland of Rhodes grass, black spear grass and blue grasses

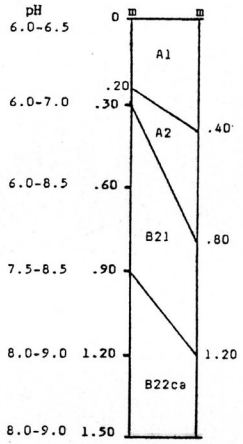
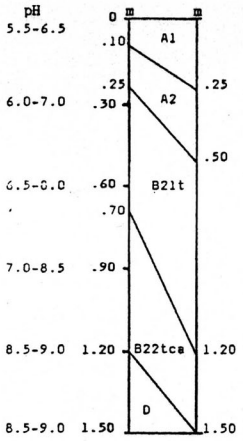
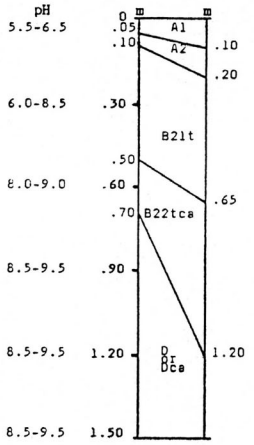
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
6Ufd	Uf6.32 Uf6.31		Non-cracking friable clay: Hard setting surface. A1: Dark (7.5YR, 10YR 2/1, 2/2, 3/1); light to light medium clay; strong, medium blocky; dry very hard. Gradual to diffuse to - B2: Dark to brown (7.5YR, 10YR 3/1, 3/2, 3/3, 4/4, 4/6); light to light medium clay; moderate, medium blocky to subangular blocky; dry hard. Clear to gradual to - D: Brown to yellow (7.5YR, 10YR 4/6, 5/4, 5/6, 6/6); sand to loamy sand; single grain; dry loose.	Miscellaneous alluvial land-forms Flood-outs, fans and levees	Open woodland of poplar gum, grey bloodwood and carbeen with cocky apple associated with Tussock grassland of blue grasses and black spear grass
6Ufe	Uf6.22 Uf6.23		Alluvial soil: A11: (frequently present) Weak medium to fine granular self-mulch (when absent, surface is hard setting). A12: Moderately brown-mottled dark to grey (7.5YR, 10YR 3/1 to 4/2); light to medium clay; moderate to strong, medium to fine granular to blocky; dry very hard. Abrupt to - D1: Grey to brown (7.5YR, 10YR 4/2, 4/3, 4/4); sand to coarse sand; single grain; dry loose. Abrupt to - D2 et seq: One or more of the following - (a) Moderately to strongly brown-mottled dark to grey (10YR, 2.5Y 3/1 to 4/2); sandy clay to medium clay; moderate to strong, medium to fine prismatic to blocky; dry very hard; occasionally subrounded and rounded pebbles. (b) Grey to brown (7.5YR, 10YR 4/2, 4/3, 4/4); sand to coarse sand; single grain; dry loose. Frequently moderately brown-mottled grey to yellow-brown (10YR, 5/2 to 6/3); sandy loam to sandy clay loam; moderate medium blocky; dry hard. Variations: Texture of D1 horizon sandy clay loam. D1 horizon conspicuously bleached. D2 clay horizon bleached in upper 0.05 m.	Miscellaneous alluvial land-forms Flood-outs, fans and levees	Open woodland to woodland to poplar gum, cabbage gum and tea-tree spp. with Parkinsonia associated with Tussock grassland of blue grasses and black spear grass with brown sorghum associated
6Uga	Ug5.16 Ug5.17 Uf6.32 Uf6.33		Black earth and grey clay and non-cracking friable clay: Occasionally weak gilgai, weakly cracking to non-cracking. A11: (occasionally present) Weak to moderate fine granular self-mulch (when absent, surface is hard setting). A12: Dark to grey (7.5YR, 10YR 2/1 to 5/2); light to light medium clay; moderate to strong, fine subangular blocky to blocky to granular; dry hard. Clear to - B21: Dark to grey (7.5YR, 10YR 2/1 to 4/2); light to medium clay; strong, medium to fine subangular blocky to blocky; dry hard to very hard. Clear to - B22 or B22ca: Frequently moderately brown-mottled grey to brown (7.5YR, 10YR 4/1 to 5/4); light medium to medium clay; strong, medium blocky to lenticular; dry very hard; frequently trace to small amounts of concretionary carbonate. Abrupt to clear to - D: Occasionally moderately brown-mottled grey to brown (7.5YR, 10YR 4/2 to 5/4); sandy clay to medium clay; weak to moderate, medium blocky to lenticular; dry very hard; occasionally small amounts of subrounded and rounded pebbles. Variations: A horizon weakly mottled. Bleached A2 horizon (Ug3.1).	Miscellaneous alluvial land-forms Levees, closed and open depressions	Open woodland to woodland of poplar gum, cabbage gum and grey bloodwood with carbeen, and red bloodwood associated with Tussock grassland of black spear grass and blue grasses. Rubber vine is dominant in some cleared areas.

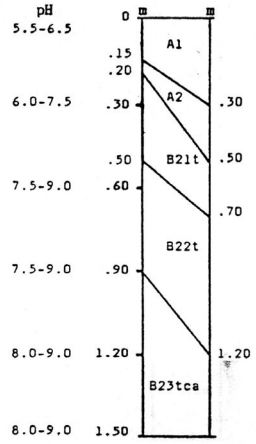
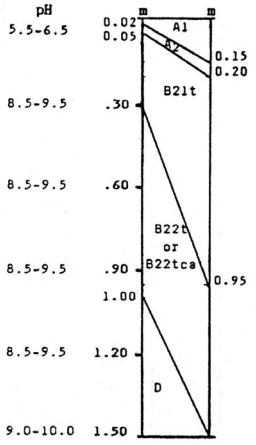
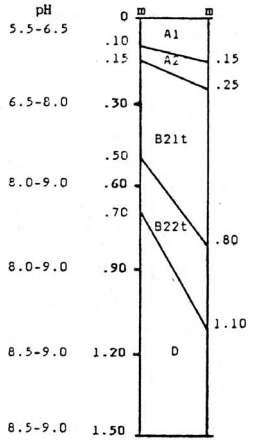
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
6Ugc	Ug2 Ug3.2 Uf3		<u>(Bleached) grey clay - (bleached) non cracking clay</u>: Weak gilgai, weakly cracking non-cracking, hard setting surface. <u>Mound</u>: A1: Moderately brown-mottled dark to grey (10YR, 2.5Y 3/1 to 4/2); light clay; massive to weak, medium subangular blocky; dry hard. Abrupt to clear to - A2: As above with sporadic or conspicuous bleach. Abrupt to clear to - B21: Grey (10YR, 2.5Y 4/1, 4/2); light medium to medium clay; strong, medium to fine blocky to lenticular; dry hard; Clear to - B22ca: Grey (10YR, 2.5Y 4/1 to 5/2); light medium to medium clay; strong, medium to fine blocky to lenticular; dry hard; small amounts of concretionary carbonate. Clear to - Dca: Grey to brown (10YR 4/1 to 4/3); light clay; moderate medium blocky; dry hard; small amounts of concretionary carbonate. Ferromanganiferous nodules throughout B and D horizons. <u>Depression</u>: Similar morphology but weak to moderately cracking surface and moderately to strongly mottled A horizon.	Miscellaneous alluvial land-forms Backplain, closed and open depressions	Low open woodland to low woodland of cabbage gum, poplar gum and carbeen with cocky apple associated. with Tussock grassland of blue grasses, kangaroo grass and black spear grass Rubber vine is dominant in some areas
6Gna	Gn3.22 Gn3.92 Gn3.42 Db1.13 Db1.12 Dd1.12 Dd1.13 Dy2.12		<u>Brown, grey and black smooth-ped earth and hard pedal duplex soil</u>: Hard setting surface. A: Dark (7.5YR, 10YR 2/1 to 3/2); clay loam to fine sandy clay loam; massive to moderate, medium blocky, dry hard. Gradual to - B2: Dark to brown (7.5, 10YR 2/1 to 4/4); light to medium clay; strong, medium to fine blocky; dry extremely hard. Gradual to - D: Brown (7.5YR, 10YR 3/3 to 5/4); sandy clay loam to sandy clay; moderate, medium blocky, dry hard. <u>Variations</u>: A horizon texture silty clay to light clay (PPF Uf6.31). A2, A3 or B1 between 30 and 40 cm (Includes PPF Gn3.95). <u>Variant</u>: 6Gna2 - layered course sand to medium clay. D horizon or buried soils below 0.60m.	Miscellaneous alluvial land-forms Levees, back-plains and fans	Low open woodland to low woodland of carbeen, cabbage gum, poplar gum and grey bloodwood with coral tree, leichhardt tree and cocky apple associated with Tussock grassland of giant spear grass, black spear grass and brown sorghum
6Gnd	Gn3.75 Gn3.72 Gn3.22 Gn3.92 Gn3.82		<u>Yellow and brown smooth-ped earth</u>: Hard setting surface. A1: Grey to dark or brown (7.5YR, 10YR 3/1, 3/2, 4/2, 4/3); sandy loam to clay loam; massive to weak, medium blocky; dry slightly hard. Clear to - A2 or A3: Brown to yellow-brown (7.5YR, 10YR 4/2 to 4/6, 5/4 5/6); fine sandy loam to clay loam; massive to weak, medium blocky; dry hard; occasionally with sporadic bleach. Clear to - B2: Brown to yellow-brown (7.5YR, 10YR 4/3 to 5/6, 6/6); clay loam to light clay; moderate, medium to fine blocky to prismatic; dry extremely hard. Ferromanganiferous nodules throughout B2 horizon. <u>Variation</u>: Red to red-brown (5YR 4/4 to 5/4); sandy clay loam to clay loam D horizon below 1.00 m.	Miscellaneous alluvial land-forms Levees, flood-outs and fans.	Woodland to open wood-land of carbeen, cabbage gum and poplar gum with red and grey bloodwood and cocky apple associated with Tussock grassland of bleak spear grass and giant spear grass with brown sorghum and blue grasses associated

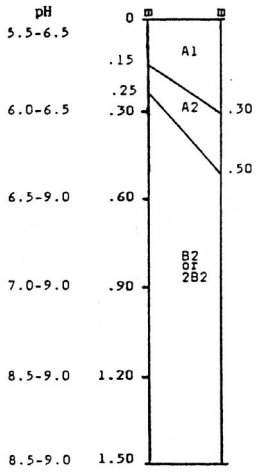
Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
6Gne	Gn3.49 Gn3.03 Gn3.06		<u>Bleached black and grey smooth-ped earth:</u> Hard setting surface. A1: Dark to grey (7.5YR, 10YR 3/1, 4/1); clay loam to fine sandy clay loam; massive to moderate, medium subangular blocky; dry hard. Abrupt to clear to - A2: As above with sporadic or conspicuous bleach. Abrupt to clear to - B21: Dark to grey (7.5YR, 10YR, 3/1,4/1,4/2); light clay; strong, medium to fine subangular blocky; dry very hard. Clear to - B22 or B22ca: As above with trace to small amounts of concretionary carbonate. Ferromanganiferous nodules throughout B horizons. <u>Variation</u>: D horizon of red to brown (5YR, 7.5YR 4/8, 5/4, 5/6); fine sandy clay loam to fine sandy clay below 1.00 m.	Miscellaneous alluvial landforms Backplain and channel benches	Low open woodland to open woodland of poplar gum and cabbage gum with grey bloodwood cocky apple whitewood and willow wattle associated with Tussock grassland of black spear grass and giant spear grass with blady grass and brown sorghum associated
6Drc	Dr3.33 Dr3.43 Dr2.33 Dr2.43		<u>Red solodic-solodized solonetz:</u> Hard setting surface. A1: Frequently moderately brown-mottled dark to grey (7.5YR, 10YR 2/1, 3/1, 3/2, 4/2); loam to clay loam; weak to moderate, medium to fine subangular blocky; dry slightly hard. Abrupt to - A2: As above but grey to brown (7.5YR, 10YR 4/2, 4/3, 4/4, 5/2, 6/2) with conspicuous or sporadic bleach. Abrupt to - B21t: Frequently moderately yellow to grey-mottled red to red-brown (2.5YR, 5YR 4/3 to 4/8, 3/4, 3/6); medium clay to medium heavy clay; strong, coarse to medium columnar or prismatic breaking to medium to fine blocky; dry very hard to extremely hard. Gradual to diffuse to - B22t As above but strong medium to fine prismatic to medium blocky. Clear to - B22tca: As above but with small amounts of concretionary carbonate. Clear to - D: Frequently yellow-mottled red-brown to brown(5YR, 7.5Y 4/4, 5/4 5/6); fine sandy clay to medium clay; strong medium blocky to prismatic; dry hard to very hard; trace to small amounts of concretionary carbonate. Ferromanganiferous nodules frequently throughout. <u>Variations</u>: A2 horizon not bleached. D horizon has small amounts of gravel. Texture of D horizon sandy clay loam to clay loam.	Miscellaneous alluvial landforms Levees, and flood-outs and fans	Open woodland of grey bloodwood and poplar gum with carbeen, cabbage gum, cocky apple and beefwood associated with Tussock grassland of black spear grass, blue grasses and giant spear grass with kangaroo grass associated
6Dba	Db1.33 Db1.43 Dy2.33		<u>Brown and grey solodic-solodized solonetz:</u> Hard setting surface. A1: Dark to brown or grey (7.5YR, 10YR 3/1 to 4/3); sandy loam to sandy clay loam; massive to weak, medium blocky; dry hard. Abrupt to - A2: As above with sporadic or conspicuous bleach. Abrupt to - B21t: Occasionally weakly yellow-mottled brown to yellow-brown or grey (7.5YR, 10YR 4/3 to 5/4, 5/2); light to medium clay; strong, coarse columnar to blocky breaking to medium to fine blocky to prismatic; dry very hard; frequently trace amounts of concretionary carbonate. Clear to gradual to - B22t or B22tca: As above but strong, medium to fine to prismatic with trace to moderate amounts of concretionary or soft carbonate. Ferromanganiferous nodules throughout B horizons. <u>Variations</u>: A2 horizon not bleached (PPF Db1.23). D horizon of sandy clay to medium clay below 0.60m.	Miscellaneous alluvial landforms Flood-outs, fans and levees	Low open to low woodland of carbeen, grey bloodwood and cabbage gum with poplar gum, whitewood, beefwood and mimosa associated with Tussock grassland of black spear grass, blue grasses and Rhodes grass

Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
6Dbb	Db1.33 Db1.43 Dy2.43 Dy2.33 Dd1.33 Dd2.43		<u>Brown, grey and dark solodic soil</u>: Hard setting surface. A1: Dark to grey (7.5YR, 10YR 3/1 to 4/2); clay loam to fine sandy clay loam; strong medium to fine blocky; dry hard. Abrupt to - A2: As above with sporadic or conspicuous bleach. Abrupt to - B21t: Brown to grey to dark (7.5YR, 10YR 3/1 to 4/3, 4/4); light medium to medium clay; strong, coarse prismatic breaking to medium to fine prismatic to blocky; dry very hard. B22t or B22tca: As above with trace to small amounts of concretionary carbonate. Abrupt to - D or Dca: Brown to yellow-brown (7.5YR, 10YR 4/3, 5/3, 5/4); fine sandy loam to light medium clay; massive to weak to strong, coarse to medium prismatic; dry hard; trace to small amounts of concretionary carbonate. Ferromanganiferous nodules throughout B and D horizons. <u>Variation</u>: D horizon colour - brown to red-brown (5YR 5/4. 5/6).	Miscellaneous alluvial landforms Backplain and channel benches	Low open woodland to low woodland of poplar gum, cabbage gum, carbeen and grey bloodwood with cocky apple associated with Tussock grassland of black spear grass, giant spear grass and brown sorghum
6Dbc	Db1.32 Db1.22 Dy2.32 Dy2.22		<u>Grey-brown podzolic soil</u>: Hard setting surface. A1: Dark to brown (7.5YR, 10YR 2/2, 3/1 to 3/3); fine sandy loam to fine sandy clay loam; massive to weak, medium blocky; dry soft to slightly hard. Abrupt to - A2: As above but brown to yellow-brown (7.5YR, 10YR 4/3, 4/4, 5/3); frequently with sporadic bleach. Abrupt to - B2t: Brown to yellow brown (7.5YR, 10YR 4/3 to 4/6, 5/4, 5/6); light medium to medium clay; strong, medium to fine subangular blocky; dry hard. Clear to - D1: Brown to yellow-brown (7.5YR, 10YR 3/3 to 5/4, 4/6); sandy loam to sandy clay loam; weak, coarse to medium subangular blocky; dry slightly hard. Clear to - D2: (occasionally present) Brown to grey (7.5YR, 10YR 3/3, 4/2, 4/3); light to light medium clay; strong medium to fine blocky; dry hard. Ferromanganiferous veins and nodules throughout B and D horizons. <u>Variation</u>: D horizon of medium clay below 0.9 m.	Miscellaneous alluvial landforms Levees	Woodland to low woodland of poplar gum, grey bloodwood and carbeen with cocky apple associated with Tussock grassland of black spear grass, giant spear geass, brown sorghum and kangaroo grass
6Dbe	Db2.33 Db2.43 Db1.43 Db1.33 Db2.32		<u>Red-brown earth:</u> Hard setting surface. A1: Moderately brown-mottled dark to brown (7.5YR, 10YR 3/2, 3/3); fine sandy loam to fine sandy clay loam; massive to weak, subangular blocky, dry hard. Abrupt to - A2: As above with sporadic or conspicuous bleach. Abrupt to - B21t: Frequently moderately red-mottled brown (7.5YR, 10YR 3/4, 4/4, 4/6); medium to medium-heavy clay; strong, coarse prismatic; dry extremely hard. Clear to - D1: As above, but sandy clay to light medium clay, argillans always present. Clear to - D2ca: As above, but with small amounts of concretionary carbonate. Clear to - D3: Occasionally moderately brown-mottled brown to yellow-brown (7.5YR 4/4, 4/6, 5/6); loamy sand equivalent to clay loam sandy; weak, medium subangular blocky to blocky; dry soft to slightly hard. Clear to - D4: Brown to grey (7.5YR, 10YR 3/3, 4/2, 4/3); light to light meidum clay; strong, medium blocky; dry hard. Ferromanganiferous nodules throughout.	Miscellaneous alluvial landforms Levees, floodouts and fans	Open woodland to open forest of poplar gum, carbeen and red and grey bloodwood with beefwood and cocky apple associated. Occasionally open forest of tea-tree with Tussock grassland of blue grasses, black spear gras and golden beard grass

Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
6Dbf	Db1.22 Db1.12 Dy2.22 Dy2.12		Brown podzolic soil: Hard setting surface. A1: Dark to brown (7.5YR, 10YR 3/2 to 4/3); sandy loam to loam fine sandy; massive to weak, fine blocky; dry slightly hard. Abrupt to clear to - A2, A12 or A3: Brown to yellow-brown (7.5YR, 10YR 4/2 to 4/6, 5/3, 5/4); fine sandy loam to fine sandy clay loam; massive to weak, medium blocky to thick platy; dry hard. Abrupt to clear to - B2t: Brown to yellow-brown (7.5YR, 10YR 4/3 to 4/6, 5/3, 5/4); fine sandy clay to medium clay; moderate to strong, medium to fine blocky to prismatic; dry hard. Clear to - D: Brown to yellow-brown (7.5YR, 10YR 4/4 to 5/6); loam to fine sandy clay; weak, moderate blocky to prismatic; dry hard. Variation: Colour of upper B horizon grey-brown (7.5YR 4/2 to 5/2). Variant: 6Dbf2-Dhorizon of coarse sand to light sandy clay loam below 0.50 m.	Miscellaneous alluvial landforms Levees, flood-outs, fans and prior streams	Open woodland to woodland of poplar gum, and red bloodwood, carbeen and grey ironbark with cocky apple associated with Tussock grassland of blue grasses, black spear grass and giant spear grass with golden beard grass associated
6Dbh	Db1.43 Db1.33 Db2.33		Brown solodic-solodized solonetz: Hard setting surface. A1: Occasionally moderately brown-mottled dark to grey or brown(7.5YR, 10YR 3/2 to 4/3); loam to fine sandy clay loam; massive to weak, thick platy; dry slightly hard. Abrupt to - A2: As above with sporadic or conspicuous bleach. Abrupt to - B21t: Occasionally moderately brown-mottled brown (7.5YR, 10YR 3/3, 4/3 to 4/6); light to medium clay; strong, coarse blocky to columnar breaking to medium to fine blocky to prismatic; dry extremely hard. Clear to - B22t or B22tca: (frequently present) As above with trace to small amounts of concretionary soft carbonate. Clear to - D or Dca: Brown to yellow-brown or grey (7.5YR, 10YR 4/2, 4/3 to 6/4); clay loam to medium clay; moderate to strong, medium to fine prismatic to blocky; dry hard; trace to small smounts of concretionary carbonate. Ferromanganiferous nodules throughout B and D horizons. Variations: Small amounts of concretionary gypsum in B22t. A2 horizon not bleached (Db1.23). Variant: 6Dbh2 - D horizon sandy loam to light sandy clay loam.	Miscellaneous alluvial landforms Levees and backplains	Low open woodland to low woodland of beefwood, false sandalwood and carbeen with cabbage gum and grey ironbark associated. Tall open scrubland of beefwood occurs with Open tussock grassland of purple top Rhodes grass and blue grasses
6Dyb	Dy3.32 Dy3.42 Dy3.31 Dy3.41		Yellow podzolic soil: Hard setting surface. A1: Occasionally weakly brown-mottled dark to brown (10YR 2/1 to 4/2, 4/3); loamy sand, sandy loam or sandy clay loam; massive to weak, medium subangular blocky; dry slightly hard. Abrupt to - A2: Grey to yellow-brown (7.5YR, 10YR 5/2 to 6/3, 5/4); loamy sand to sandy loam; massive dry slightly hard; sproadic or conspicuous bleach. Abrupt to - B21t: Moderately to strongly yellow-mottled yellow-brown to grey (7.5YR, 10YR 2.5Y 5/2 to 6/4, 5/6, 5/8); sandy clay to light medium clay; strong, coarse blocky to prismatic; dry very hard. Gradual to diffuse to - B22t: As above but light medium to medium clay. Variant: 6Dyb2- D horizon of sand to sandy loam or medium clay occur below 0.60m.	Miscellaneous alluvial landforms Flood-outs, fans and levees	Open woodland of poplar gum and grey bloodwood with carbeen cocky apple and cabbage gum associated with Tussock grassland of black spear grass, blue grasses and giant spear grass

Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
6Dye	Dy3.43 Dy3.33 Dy2.43 Dy2.33		Grey and yellow solidic-solidized solonetz: Hard setting surface. A1: Frequently moderately brown-mottled grey to brown or dark (7.5YR, 10YR 3/1 to 4/2 , 4/3); loamy sand to light sandy clay loam; massive to weak, subangular blocky; dry slightly hard. Abrupt to - A2: As above but frequently yellow-brown to brown (7.5YR, 10YR 5/3 to 6/4, 7/3); and texture frequently sand, sporadic or conspicuous bleach. Abrupt to - B21: Frequently moderately to strongly brown to red-mottled grey to yellow (10YR, 2.5Y 5/1 to 6/4, 5/6); light medium to medium heavy clay; strong, coarse columnar to blocky breaking to medium prismatic to blocky; dry extremely hard. Clear to - B22ca: As above but medium prismatic to blocky with small amounts of concretionary carbonate. Ferromanganiferous nodules frequently throughout. Variations: D horizons of dark to grey (10YR 3/1, 4/1) medium clay with rounded and subrounded pebbles below 0.90 m. D horizon of grey (10YR 6/4) sandy clay loam below 1.20 m.	Miscellaneous alluvial landforms Flood-outs, fans and levees	Open woodland to low open woodland of poplar gum grey bloodwood and tea-tree spp. with beefwood and cabbage gum associated with Tussock grassland of black spear grass and giant spear grass
6Dyf	Dy3.43 Dy3.33 Db2.43 Db2.33		Yellow and brown solodic-solodized solonetz: Hard setting surface. A1: Frequently moderately brown-mottled grey to dark (10YR 3/1 to 4/2); loam to fine sandy clay loam; massive to weak medium subangular blocky; dry slightly hard. Abrupt to - A2: As above but grey to yellow-brown (10YR 4/2, 5/2, 5/3, 6/3); sporadic or conspicuous bleach. Abrupt to - B21t: Moderately to strongly red to brown-mottled yellow-brown to brown (7.5YR, 10YR 4/4, 4/6, 5/6, 5/3 to 6/4); light medium to medium heavy clay; strong, coarse columnar to blocky breaking to medium prismatic to blocky; dry very hard to extremely hard. Clear to - B22tca: Moderately yellow-mottled brown to red-brown (5YR, 7.5YR 4/3 to 6/6); light medium to medium clay; strong medium blocky; dry very hard, frequently small amounts of concretionary varbonate. Clear to gradual to - D: As above but light to light medium clay and moderate medium blocky. Ferromanganiferous nodules throughout B and D horizons. Variation: D horizon of yellow (10YR 6/6) fine sandy clay loam below 1.20m.	Miscellaneous alluvial landforms Flood-outs, fans and levees	Woodland to low woodland of poplar gum and grey bloodwood with cocky apple associated with Tussock grassland of black spear grass, giant spear grass and kangaroo grass.
6Dyg	Dy3.43 Dy2.43 Dy3.33 Dy2.33 Db2.43		Grey and brown solodic-solodized solonetz: Hard setting surface. A1: Frequently moderately brown-mottled grey to brown or dark (7.5YR, 10YR 3/2 to 4/3, 4/1); loam to fine sandy clay loam; massive to weak medium subangular blocky to platy; dry slightly hard. Abrupt to - A2: As above with conspicuous or sporadic bleach. Abrupt to - B21t: Frequently weak to moderately brown-mottled grey to yellow or brown (10YR, 2.5Y 4/1, 4/2, 4/3, 5/3, 5/4, 5/6); light medium to medium heavy clay; strong, coarse columnar to blocky breaking to medium blocky and prismatic; dry extremely hard. Clear to - B22tca: As above but strong medium blocky with small to moderate of concretionary carbonate. D or Dca: Frequently moderately brown-mottled yellow-brown to brown or grey (10YR 4/2 to 5/4, 4/6, 5/6); fine sandy clay loam to light medium clay; moderate medium blocky to lenticular; dry very hard, frequently trace to moderate amounts of concretionary carbonate. Ferromanganiferous concretions frequently throughout. Variation: B21t horizon dark (10YR 2/2, 3/2, 3/1) (Dd1.43, Dd2.43) Variant: 6Dyg2 - D horizon of coarse sand to sandy clay loam below 0.70m.	Miscellaneous alluvial landforms Flood-outs, fans and levees	Low open to open woodland of carbeen, cabbage gum, poplar gum, beefwood and false sandalwood with grey bloodwood and cocky apple associated with Open tussock grassland of black spear grass and purple top Rhodes grass

Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
6Dyh	Dy3.43 Dy2.43 Dy2.33 Dy3.33		Grey solodic-solodized solonetz: Hard setting surface. A1: Occasionally weakly to moderately brown-mottled dark to brown (7.5YR, 10YR 3/1, 3/2 to 4/3); sand to sandy loam; massive dry very hard. Abrupt to - A2: As above but grey (7.5YR, 10YR 4/2, 5/2, 6/2); conspicuous or sporadic bleach. Abrupt to - B21t: Frequently moderately yellow-mottled grey (10YR, 2.5Y 4/1, 4/2, 5/2); light medium to medium clay; strong, coarse to medium columnar to blocky; dry extremely hard. Gradual to diffuse to - B22t: As above but medium prismatic to blocky. Clear to - B23tca: As above with small amounts of concretionary carbonate. Variant: 6Dyh2 - D horizons of dark to grey (10YR 3/1, 4/1); light to medium clay or grey (10YR 4/2 to 6/2, 6/1); sand to sandy loam below 0.70 m.	Miscellaneous alluvial landforms Flood-outs fans and levees	Low open to open woodland of poplar gum, cabbage gum, carbeen and beefwood with grey bloodwood, false sandalwood, dead finish, chinee apple and cocky apple associated with Tussock grassland of black spear grass and love grasses with blue grasses and purple top Rhodes grass associated
6Dyj	Dy3.43 Dy2.43 Dy3.33 Db2.43 Dd1.43		Grey, brown and dark solodic-solodized solonetz: Hard setting surface. A1: Dark to grey (7.5YR, 10YR 2/1, 3/2 to 4/2); sandy loam to clay loam; massive to weak, medium blocky; dry slightly hard. Abrupt to - A2: As above with sporadic or conspicuous bleach. Abrupt to - B21t: Frequently moderately brown-mottled grey to yellow-brown or dark (7.5YR, 10YR 3/2 to 4/3, 5/3,5/4); light medium to medium heavy clay; strong, coarse columnar or blocky breaking to medium to fine blocky to prismatic; dry very hard; small to moderate amounts of concretionary carbonate. Clear to - B22t or B22tca: As above but strong, medium to fine blocky to prismatic, moderate to large amounts of concretionary of soft carbonate. Clear to - D: Frequently moderately brown-mottled grey-brown to yellow-grey (7.5YR, 10YR, 2.5Y 5/2 to 6/4); sand to medium clay occasionally with gravel, single grain to strong, medium blocky to lenticular; dry loose to hard.	Miscellaneous alluvial landforms Flood-outs, fans and levees	Low open to open woodland of poplar gum, cabbage gum and false sandalwood with carbeen, grey bloodwood and corkwood associated with Open tussock grassland of blue grasses, giant spear grass, black spear grass and purple top Rhodes grass
6Dda	Dd1.43 Dd1.33		Dark solodic-solodized solonetz: Hard setting surface. A1: Occasionally weakly brown-mottled dark to brown (7.5YR, 10YR 2/1, 3/1, 3/2, 3/3, 4/3,); clay loam to fine sandy clay loam; massive to weak, medium to fine blocky; dry hard. Abrupt to - A2: As above with conspicuous or sporadic bleach. Abrupt to - B21t: Dark (7.5YR, 10YR 2/1 to 3/2); light medium to medium clay; strong, coarse columnar to blocky breaking to medium to fine prismatic to blocky; dry very hard. Gradual to - B22t: Dark to grey (7.5YR, 10YR 2/1 to 3/2, 4/1, 4/2); light medium to medium clay; strong, medium to fine blocky to lenticular; dry very hard; trace amounts concretionary carbonate. Gradual to - D: Occasionally moderately yellow-mottled dark to grey to brown (7.5YR, 10YR 3/1 to 5/2, 3/3, 4/3); clay loam to light medium clay; moderate to strong, medium to fine subangular blocky to blocky; dry very hard. Variant: 6Dda2 - D horizon of sand to sandy loam below 0.70m.	Miscellaneous alluvial landforms Closed and open depressions	Low open woodland to open woodland of poplar gum, carbeen, cabbage gum and beefwood with grey bloodwood associated with Tussock grassland of black spear grass, blue grasses and Rhodes grass

Soil Type	P.P.F.	Profile Diagram	Description of Soil Type	Landscape Unit	Predominant Natural Vegetation
6Ddb	Dd1.43 Dy2.43 Dd1.33 Dy2.33		Dark and grey solodic soil: Hard setting surface. A1: Occasionally weakly brown-mottled dark to grey (7.5YR, 10YR 2/1 to 4/2); coarse sand to sandy loam or sandy clay loam; massive; dry hard. Abrupt to - A2: As above with conspicuous or sporadic bleach. Abrupt to - B2 or 2B2: Dark to grey (7.5YR, 10YR 2.5Y 2/1 to 4/1, 2/2, 3/2); medium clay to medium heavy clay; strong, medium blocky to lenticular; dry very hard; sand lenses, rounded and subrounded pebbles frequently present. Variations: B21 horizon from 0.35 - 0.75 m, moderately to strongly yellow-mottled grey (10YR, 2.5Y 4/1 to 5/2).	Miscellaneous alluvial land-forms Flood-outs, fans and levees	Low open woodland of poplar gum, carbeen, cabbage gum and beef-wood with grey bloodwood and cocky apple associated with Tussock grassland of blue grasses and black spear grass

APPENDIX III MORPHOLOGICAL AND ANALYTICAL DATA OF THE SAMPLED SOIL TYPES

SOIL TYPE: 2Ugh
SITE NO: S01
A M G. REFERENCE: 526 740 mE 7 805 420 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.28
SOIL TAXONOMY UNIT: Entic Chromustert
FAO UNESCO UNIT: Pellic Vertisol

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL. 0.25 m
HORIZONTAL INTERVAL: 7 m
SURFACE COARSE FRAGMENTS: Very few
COMPONENT OF MICRORELIEF SAMPLED: Mound

SUBSTRATE MATERIAL. Unconsolidated substrate materials
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE: 0.2%
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE: Plain

VEGETATION
STRUCTURAL FORM: Tussock grassland with isolated trees
DOMINANT SPECIES. Parkinsonia aculeata, Cryptostegia grandiflora, Cyperus species

ANNUAL RAINFALL:

PROFILE MORPHOLOGY.
CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking, self mulching

HORIZON	DEPTH	DESCRIPTION
A11	0 to .01 m	Medium heavy clay, very few manganiferous concretions. Abrupt to-
A12	01 to 08 m	Yellowish grey (2.5Y4/1); common fine faint yellow mottles; medium heavy clay, strong 5-10mm angular blocky; very firm, very few manganiferous concretions. Clear to-
B21	.08 to .30 m	Yellowish grey (2.5Y4/1); few fine faint yellow mottles, medium heavy clay, strong 50-100mm lenticular parting to 5-10mm lenticular, moderately strong, few manganiferous concretions Diffuse to-
B22k	.30 to .70 m	Yellowish grey (2.5Y4/1), few fine faint yellow mottles, medium heavy clay, strong 50-100mm lenticular parting to 5-10mm lenticular, few clay skins, moderately strong, few manganiferous concretions, few carbonate concretions Diffuse to-
B23k	.70 to 1.30 m	Yellowish grey (2.5Y5/1), medium heavy clay, strong 50-100mm lenticular parting to 5-10mm lenticular; many clay skins, moderately strong, few manganiferous concretions, few carbonate concretions. Diffuse to-
B24	1.30 to 1.75 m	Dark greyish yellow (2.5Y5/2), medium heavy clay; strong 50-100mm lenticular parting to 10-20mm lenticular; many clay skins, moderately strong; very few manganiferous concretions, very few carbonate concretions. Diffuse to-

Depth metres	1:5 Soil/Water pH	EC mS/cm @105C	Cl %	Particle Size CS FS S %	C % @105C	Exch. Cations CEC m.eq/100g	Ca	Mg	Na	K @105C	Total Elements P %	K @80C	S %	Moistures ADM 1/3b % @105C	15b	Disp.Ratio R1	R2
Bulk .10	7.0	.04	.002														
.10	6.9	.02	.002	4	15 22 62	38	20	16	.80	.55	.022	0.95	.005	5.6	33 19	.55	
.30	8.5	.05	.002	2	18 17 61	37	21	17	1.3	.48	.016	0.96	.012	5.7	34 19	.73	
.60	8.9	.19	.020	3	19 19 60	38	19	19	3.0	.39	.016	1.00	.004	5.6	36 20	.81	
.90	8.8	.31	.045	2	18 19 61	37	16	18	4.6	.38	.017	1.02	.004	5.4	36 21	.91	
1.20	9.0	.45	.074	2	18 21 61	35	14	17	6.1	.40	.016	1.01	.004	5.5			
1.50	8.8	.54	.100														

Depth metres	Org.C (W&B) % @105C	Tot.N % @105C	Extr. Phosphorus Acid ppm @105C	Bicarb. @105C	Rep. K m.eq% @105C	DTPA-extr. Fe ppm @105C	Mn	Cu	Zn
Bulk .10	0.8	.08	15	18	.68	61	29	2.5	0.4

SOIL TYPE: 2Dyb
SITE NO: S02
A M G. REFERENCE: 526 010 mE 7 805 220 mN ZONE 55

GREAT SOIL GROUP: Solodized solonetz
PRINCIPAL PROFILE FORM: Dy2.43
SOIL TAXONOMY UNIT: Typic Natrustalf
FAO UNESCO UNIT: Solodic Planosol

SURFACE COARSE FRAGMENTS: Very few

SUBSTRATE MATERIAL: Unconsolidated substrate materials
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE: 0.5 %
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE: Plain

VEGETATION
STRUCTURAL FORM: Open woodland
DOMINANT SPECIES: Eucalyptus papuana, Eucalyptus alba, Eucalyptus tessellaris, Parkinsonia aculeata

ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1sb	0 to .20 m	Greyish brown (7.5YR4/2) moist, dry sporadically bleached, common fine distinct brown mottles, clay loam,fine sandy, massive, very firm. Clear to-
A2cb	.20 to .20 m	Greyish brown (7.5YR4/2) moist; dry conspicuously bleached, common fine distinct brown mottles, clay loam,fine sandy; massive; very firm. Abrupt to-
B21t	.20 to 35 m	Yellowish grey (2.5Y4/1) moist, medium clay, strong 20-50mm prismatic parting to 5-10mm prismatic moderately strong, very few manganiferous concretions. Gradual to-
B22t	.35 to .60 m	Yellowish grey (2.5Y4/1) moist; medium clay; strong 20-50mm lenticular parting to 5-10mm lenticular, many clay skins; moderately strong; very few carbonate concretions, very few manganiferous concretions, very few carbonate soft segregations. Gradual to-
B23t	.60 to .95 m	Yellowish grey (2.5Y4/1) moist; medium clay; strong 20-50mm lenticular parting to 5-10mm lenticular; many clay skins; moderately strong; very few carbonate concretions, very few manganiferous concretions, very few carbonate soft segregations. Diffuse to-
D1?	.95 to 1.50 m	Dull yellowish brown (10YR5/4) moist, light medium clay, strong 20-50mm lenticular parting to 5-10mm lenticular; many clay skins; moderately strong; very few carbonate concretions, very few manganiferous concretions, very few carbonate soft segregations. Diffuse to-
D2?	1.50 to 2.00 m	Dull yellow (2.5Y6/3) moist, light medium clay, strong 20-50mm lenticular parting to 10-20mm lenticular; many clay skins; moderately strong, very few carbonate concretions, very few manganiferous concretions, very few carbonate soft segregations.

Depth metres	1:5 Soil/Water pH	EC mS/cm @105C	Cl %	Particle Size CS FS S %	C % @105C	Exch. Cations CEC m.eq/100g	Ca	Mg	Na	K @105C	Total Elements P %	K @80C	S %	Moistures ADM 1/3b % @105C	15b	Disp.Ratio R1	R2
Bulk .10	6.1	.03	.003														
.10	6.3	.01	.001	4	63 17 18	14	4.2	4.0	.35	.24	.021	1.24	.009	1.8	19 07	.70	
.30	7.9	.07	.009	5	37 17 43	27	8.0	13	3.8	.25	.021	1.06	.014	4.2	32 18	.87	
.60	8.9	1.0	.131	5	32 14 53	30	7.6	16	8.8	.31	.017	1.03	.044	4.5	34 19	.93	
.90	8.9	.77	.093	7	30 17 49	29	7.1	16	9.9	.32	.020	1.02	.057	4.5	34 17	.99	
1.20	9.1	.92	.109	5	30 18 49	29	9.8	15	0.3	.39	.020	1.06	.050	4.6			
1.50	9.2	.97	.112														

Depth metres	Org.C (W&B) % @105C	Tot.N % @105C	Extr. Phosphorus Acid ppm @105C	Bicarb. @105C	Rep. K m.eq% @105C	DTPA-extr. Fe ppm @105C	Mn	Cu	Zn
Bulk .10	1.0	.19	14	18	.51	87	25	1.2	0.5

APPENDIX III (Continued)

SOIL TYPE: 2Ugd
SITE NO: S03
A M G. REFERENCE: 526 700 mE 7 806 320 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Ug3.2
SOIL TAXONOMY UNIT: Entic Chromustert
FAO UNESCO UNIT: Pellic Vertisol

TYPE OF MICRORELIEF. Normal gilgai
VERTICAL INTERVAL: 0 20 m
HORIZONTAL INTERVAL. 7 m
SURFACE COARSE FRAGMENTS Very few
COMPONENT OF MICRORELIEF SAMPLED. Mound

SUBSTRATE MATERIAL. Unconsolidated substrate materials
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE: 0.2 %
LANDFORM ELEMENT TYPE.
LANDFORM PATTERN TYPE: Plain

VEGETATION
STRUCTURAL FORM: Woodland
DOMINANT SPECIES. Eucalyptus alba, Cryptostegia grandiflora, Cyperus species

ANNUAL RAINFALL:

PROFILE MORPHOLOGY
CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking, self mulching

HORIZON	DEPTH	DESCRIPTION
A11sb	0 to 03 m	Greyish yellow-brown (10YR4/2), dry sporadically bleached, common medium distinct brown mottles, light medium clay, moderate 2-5mm angular blocky. Abrupt to-
A12sb	03 to 13 m	Yellowish grey (2.5Y5/1), dry sporadically bleached; many medium distinct brown mottles, light medium clay, strong 20-50mm angular blocky parting to 2-5mm angular blocky, very few manganiferous concretions Abrupt to-
B21	.13 to .30 m	Yellowish grey (2.5Y5/1), many medium distinct brown mottles, medium clay, few subangular unspecified coarse fragments; strong 20-50mm angular blocky parting to 5-10mm angular blocky, very few manganiferous concretions. Clear to-
B22	.30 to 60 m	Dark greyish yellow (2 5Y4/2), few fine faint yellow mottles, medium clay, few subangular unspecified coarse fragments, strong 20-50mm lenticular parting to 5-10mm lenticular, many clay skins, few manganiferous concretions. Clear to-
B23k	.60 to 1.40 m	Dark greyish yellow (2.5Y4/2), few fine faint yellow mottles, medium clay, few subangular unspecified coarse fragments, strong 20-50mm lenticular parting to 5-10mm lenticular, many clay skins, few manganiferous concretions, few carbonate concretions. Diffuse to-
D	1.40 to 1.70 m	Dark greyish yellow (2.5Y5/2), light medium clay, strong 20-50mm lenticular secondary, 5-10mm lenticular, many clay skins, very few manganiferous concretions, very few carbonate concretions.

Depth (metres)	1:5 Soil/Water pH	EC mS/cm @105C	Cl %	Particle Size CS FS %	S %	C % @ 105C	Exch. Cations CEC m.eq/100g	Ca	Mg	Na	K @ 105C	Total Elements P %	K %	S % @ 80C	Moistures ADM 1/3b %	15b @ 105C	Disp.Ratio R1	R2
Bulk .10	6.0	.03	.003															
.03	5.9	.03	.002	17	25	20 42	29	6	5	8.4	30 1.1	.050	1.09	.030	3.8	35 16	.58	
.10	5.8	.02	.002													31		
.30	6 6	.02	.003	9	27	17 53	30	10	13	1.0	.49	.018	1.03	.007	4.5	32 18	.84	
.60	8.0	.16	.024	10	27	17 49	28	13	15	2.5	35	.014	0.97	.003	4.6	34 18	91	
.90	8.8	.24	.041	11	21	18 48	29	11	16	3.7	.29	.014	0.96	.003	4.5	34 18	99	
1.20	9 1	.45	.059	9	20	21 49	30	11	17	4.7	28	.011	0 96	002	4.1			
1.50	8.6	.52	.079															

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. Phosphorus Acid Bicarb. ppm @ 105C	Rep. K m.eq% @105C	DTPA-extr. Fe Mn Cu Zn ppm @ 105C
Bulk .10	1.8	.13	38 16	.73	216 44 2.7 1.2

SOIL TYPE: 6Dbh
SITE NO: S04
A M G. REFERENCE: 526 740 mE 7 807 050 mN ZONE 55

GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Db1.43
SOIL TAXONOMY UNIT: Typic Natrustalf
FAO UNESCO UNIT: Solodic Planosol

SURFACE COARSE FRAGMENTS: Very few

SUBSTRATE MATERIAL: Unconsolidated substrate materials
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE: 0.5 %
LANDFORM ELEMENT TYPE: Levee
LANDFORM PATTERN TYPE: Plain

VEGETATION
STRUCTURAL FORM: Woodland
DOMINANT SPECIES: Grevillea striata, Eucalyptus tessellaris, Grevillea striata, Acacia bidwillii, Chloris gayana, Digitaria ciliaris

ANNUAL RAINFALL

PROFILE MORPHOLOGY.
CONDITION OF SURFACE SOIL WHEN DRY:

HORIZON	DEPTH	DESCRIPTION
A1	0 to .15 m	Dull yellowish brown (10YR4/3); common fine distinct brown mottles; loam, fine sandy, massive; moderately firm. Abrupt to-
A2cb	15 to .18 m	Dull yellowish brown (10YR4/3) moist, dry conspicuously bleached, common fine distinct brown mottles, loam, fine sandy, massive, moderately firm. Abrupt to-
B21t	.18 to .35 m	Dull yellowish brown (10YR4/3), light clay, strong 20-50mm angular blocky parting to 2-5mm angular blocky; moderately strong, very few manganiferous concretions. Diffuse to-
B22t	.35 to .60 m	Dull yellowish brown (10YR4/3); light medium clay; strong 20-50mm angular blocky parting to 5-10mm angular blocky; very firm; very few manganiferous concretions. Diffuse to-
B23tk	.60 to 1.30 m	Dull yellowish brown (10YR4/3); light medium clay, strong 20-50mm angular blocky parting to 5-10mm angular blocky; very firm, few manganiferous concretions, very few carbonate concretions, few carbonate soft segregations. Clear to-
Dk	1.30 to 1.75 m	Dull orange (7.5YR6/4); medium clay; strong 20-50mm angular blocky parting to 5-10mm angular blocky; very firm; few manganiferous concretions, very few carbonate concretions, few carbonate soft segregations.

Depth (metres)	1:5 Soil/Water pH	EC mS/cm @105C	Cl %	Particle Size CS FS %	S %	C % @ 105C	Exch. Cations CEC m.eq/100g	Ca	Mg	Na	K @ 105C	Total Elements P %	K %	S % @ 80C	Moistures ADM 1/3b %	15b @ 105C	Disp.Ratio R1	R2
Bulk .10	6.2	02	.002															
.10	6.2	.01	.001	3	59	24 18	14	2.2	3.1	.45	.53	.025	1.30	.009	1.7	21 08	.75	
.30	8.2	.11	.015	2	51	17 31	20	5.0	9.3	5.0	.09	.019	1.17	.013	2.8	26 14	.94	
.60	9.3	.49	.058	2	46	18 34	23	5.1	.10	9.1	.29	.019	1.31	.044	2.8	25 13	.97	
.90	9.9	.43	.026	5	39	21 38	27	5.5	11	11	.24	.023	1.21	.039	3.4	32 17	.99	
1.20	9.9	.40	.023	5	41	21 38	25	5.8	9.9	0.0	.29	.024	1.32	.033	3.3			
1.50	9.6	.30	.023															

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. Phosphorus Acid Bicarb. ppm @ 105C	Rep. K m.eq% @105C	DTPA-extr. Fe Mn Cu Zn ppm @ 105C
Bulk .10	1.2	.10	12 11	.57	136 32 1.3 0.7

APPENDIX III (Continued)

SOIL TYPE: 1Ugf
SITE NO: S05
A M G. REFERENCE: 530 100 mE 7 806 160 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Ug2.
SOIL TAXONOMY UNIT: Entic Pellustert
FAO UNESCO UNIT: Pellic Vertisol

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL. 0.10 m
HORIZONTAL INTERVAL: 4 m
SURFACE COARSE FRAGMENTS. Very few
COMPONENT OF MICRORELIEF SAMPLED: Mound

SUBSTRATE MATERIAL. Unconsolidated substrate materials
CONFIDENCE SUBSTRATE IS PARENT MATERIAL.

SLOPE: 1 %
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE: Plain

VEGETATION
STRUCTURAL FORM:
DOMINANT SPECIES. Eucalyptus alba, Ophiurous exaltatus

ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking, self mulching

HORIZON	DEPTH	DESCRIPTION
A11cb	0 to 02 m	Brownish grey (10YR5/1), dry conspicuously bleached, few fine distinct brown mottles, few subangular unspecified coarse fragments, moderate 2-5mm angular blocky, moderately firm. Abrupt to-
A12cb	.02 to 08 m	Brownish grey (10YR5/1), dry conspicuously bleached, few fine distinct brown mottles, light medium clay, few subangular unspecified coarse fragments, moderate 5-10mm angular blocky parting to 2-5mm angular blocky; moist moderately weak Abrupt to-
B21	08 to .50 m	Brownish grey (10YR5/1), medium heavy clay, few subangular unspecified coarse fragments, strong 20-50mm lenticular parting to 5-10mm angular blocky, moist moderately weak, very few manganiferous concretions Clear to-
B22	.50 to .90 m	Yellowish grey (2 5Y5/1), medium heavy clay, few subangular unspecified coarse fragments, strong 20-50mm lenticular parting to 5-10mm lenticular, many clay skins, moist moderately firm, very few manganiferous concretions, very few carbonate soft segregations Gradual to-
B23	.90 to 1.30 m	Greyish yellow-brown (10YR6/2), medium clay, few subangular unspecified coarse fragments, strong 20-50mm lenticular parting to 5-10mm lenticular, many clay skins, moist moderately firm, very few manganiferous concretions, very few gypseous crystals, very few carbonate soft segregations. Clear to-
B24	1.30 to 1.80 m	Greyish yellow (2.5Y6/2), medium clay; few subangular unspecified coarse fragments; strong 20-50mm lenticular parting to 5-10mm lenticular, many clay skins; moist very firm; very few manganiferous soft segregations

Depth (metres)	1:5 Soil/Water pH	EC mS/cm @105C	Cl % @ 105C	Particle Size CS FS S C %	CEC	Exch. Cations Ca Mg Na K m.eq/100g @ 105C	Total Elements P %	K % @ 80C	S %	Moistures ADM 1/3b % @ 105C	15b % @ 105C	Disp.Ratio R1	R2
Bulk .10	6.5	.03	.002										
.08	6.4	.02	.002	22 29 17 31	21	5.1 6.2 .95 .43	.018	0.34 .012		2.5 21	10	.67	
.30	8.3	.06	.004	14 16 18 52	32	14 17 3.0 .18	.013	0.35 042		4.4 39	9	.99	
.60	9.2	.36	.044	14 15 14 56	31	13 17 5.3 .20	.012	0.38 .027		4.6 37	19	.99	
.90	8.8	.75	.089	13 17 17 54	33	13 16 7.6 1.3	.013	0.52 .302		5.0 37	20	.97	
1.20	8.3	.79	.112	9 19 16 56	32	10 17 8.4 .26	.013	0.72 .049		4.6			
1.50	8.0	.86	.121										

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. Phosphorus Acid Bicarb. ppm @ 105C	Rep. K %m.eq @105C	DTPA-extr. Fe Mn Cu Zn ppm @ 105C
Bulk .10	1.0	.18	5 6	.34	76 41 1 2 0.6

SOIL TYPE: 5Dyc
SITE NO: S06
A M G. REFERENCE: 530 290 mE 7 804 250 mN ZONE 55

GREAT SOIL GROUP: Solodized solonetz
PRINCIPAL PROFILE FORM: Db1.43
SOIL TAXONOMY UNIT: Mollic Natrustalf
FAO UNESCO UNIT: Solodic Planosol

SURFACE COARSE FRAGMENTS: Very few

SUBSTRATE MATERIAL. Granite
CONFIDENCE SUBSTRATE IS PARENT MATERIAL.

SLOPE: 1 %
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE: Rolling hills

VEGETATION
STRUCTURAL FORM:
DOMINANT SPECIES: Eucalyptus papuana, Eucalyptus drepanophylla, Grevillea striata

ANNUAL RAINFALL:

PROFILE MORPHOLOGY
CONDITION OF SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .17 m	Dark brown (7.5YR3/3), common medium distinct brown mottles; massive. Abrupt to-
A2cb	.17 to .20 m	Dark brown (7.5YR3/3), dry, conspicuously bleached; few medium distinct brown mottles, clay loam, sandy, massive. Abrupt to-
B21t	.20 to .30 m	Greyish yellow-brown (10YR5/2), common medium distinct brown mottles; medium clay, strong 100-200mm columnar parting to strong 10-20mm prismatic; few manganiferous concretions. Clear to-
B22t	.30 to .60 m	Olive brown (2.5Y4/3); medium clay; strong 100-200mm columnar parting to strong 10-20mm prismatic, few manganiferous concretions. Clear to-
B23tk	.60 to 1.00 m	Dull yellowish brown (10YR5/4); medium clay, strong 20-50mm angular blocky parting to 5-10mm angular blocky, very few manganiferous concretions, very few carbonate concretions. Clear to-
C	1.00 to 1.60 m	Dull yellowish orange (10YR6/3), light clay; massive; very few manganiferous concretions, very few carbonate concretions.

Depth (metres)	1:5 Soil/Water pH	EC mS/cm @105C	Cl % @ 105C	Particle Size CS FS S C %	CEC	Exch. Cations Ca Mg Na K m.eq/100g @ 105C	Total Elements P %	K % @ 80C	S %	Moistures ADM 1/3b % @ 105C	15b % @ 105C	Disp.Ratio R1	R2
Bulk .10	6.1	.03	.003										
.10	6.1	.02	.003	36 32 12 17	11	2.5 2.3 .36 .07	22	0.21 .007		1.5 15	06	.85	
.30	7.5	.02	.013	22 24 14 38	20	5.8 6.0 3.3 .08				3.0 28	15	.90	
.60	9.0	.85	.088	23 27 15 34	21	6.5 7.5 7.6 .10	.011	0.21 .022		3.2 29	13	.99	
.90	9.0	1.3	.150	25 23 14 37	22	5.8 8.0 8.8 .11				3.7 32	15	.99	
1.20	8.9	.92	.109	38 20 11 30	25	5.5 9.2 12 .11	.024	0.79 .002		3.9			
1.50	9.0	1.2	.140										

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. Phosphorus Acid Bicarb. ppm @ 105C	Rep. K %m.eq @105C	DTPA-extr. Fe Mn Cu Zn ppm @ 105C
Bulk .10	1.0	.05	14 3	.31	54 80 0.8 0.1

APPENDIX III (Continued)

SOIL TYPE: 1Dda
SITE NO. S07
A M G. REFERENCE: 527 950 mE 7 803 460 mN ZONE 55

GREAT SOIL GROUP: Solodized solonetz
PRINCIPAL PROFILE FORM: Dd1.43
SOIL TAXONOMY UNIT. Typic Natrustalf
FAO UNESCO UNIT: Solodic Planosol

SURFACE COARSE FRAGMENTS Very few

SUBSTRATE MATERIAL: Unconsolidated substrate materials
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE- 0.5 %
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE: Plain

VEGETATION
STRUCTURAL FORM: Open woodland
DOMINANT SPECIES: Eucalyptus alba, Grevillea striata

ANNUAL RAINFALL

PROFILE MORPHOLOGY.
CONDITION OF SURFACE SOIL WHEN DRY Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .07 m	Brownish grey (7.5YR4/1) moist, few fine distinct brown mottles, clay loam, massive, moderately weak Abrupt to-
A2cb	.07 to .15 m	Light grey (10YR8/1), dry conspicuously bleached, few fine distinct brown mottles, clay loam, massive, moderately weak Abrupt to-
B1t	.15 to .25 m	Greyish brown (7.5YR4/2), common fine distinct brown mottles, medium clay, few subangular unspecified coarse fragments, strong 50-100mm prismatic, very firm.
B21t	25 to .70 m	Brownish black (10YR3/1), medium clay, few subangular unspecified coarse fragments, strong 10-20mm angular blocky, moderately strong.
B22tk	70 to 85 m	Greyish yellow-brown (10YR4/2), medium clay, few subangular unspecified coarse fragments, strong 2-5mm granular, very firm; few carbonate soft segregations. Clear to-
2B23tk	85 to 1 05 m	Dull yellowish orange (10YR6/3); light clay; strong 5-10mm angular blocky, moderately firm, few manganiferous concretions, few carbonate concretions.
2B24t	1.05 to 1.50 m	Dull yellowish orange (10YR7/3), light clay, strong 5-10mm angular blocky, moderately firm, few manganiferous soft segregations, few manganiferous concretions.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	1/3b	15b	Disp.Ratio R1	R2
metres		mS/cm @105C	%	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C				
Bulk .10	6.3	.02	.003																	
.10	6.1	.03	002	9	34	33	25	13	3.5	2.9	.51	.44	.016	0.96	.011	1.9	26	08	.74	
.30	7 8	.11	.017	5	26	23	40	22	9.5	6.7	3.2	.18	.010	0.84	.007	3.3	28	15	.99	
.60	8.6	.37	.054	5	21	24	50	28	13	9.0	7.0	.15	.013	0.97	.034	4.2	33	18	.99	
.85	9.4	.54	.080	10	24	19	45	27	14	8.9	7.5	.27	.015	1.05	.025	4.2	36	16	.99	
.90	9.1	.44	069																	
1.20	8.6	.44	.066	8	38	19	34	21	8.7	6.7	6.3	.20	.013	1.28	.008	3.2				
1.50	8.5	.44	.069																	

Depth	Org.C (W&B)	Tot.N	Extr. Phosphorus Acid	Bicarb.	Rep. K	DTPA-extr. Fe	Mn	Cu	Zn
metres	% @ 105C	% @ 105C	ppm @ 105C		m.eq% @105C	ppm @ 105C			
Bulk .10	1.1	.07	6	6	.39	64	53	0.9	0.5

SOIL TYPE- 1Uga
SITE NO: S08
A M G REFERENCE- 530 200 mE 7 805 380 mN ZONE 55

GREAT SOIL GROUP. Grey clay
PRINCIPAL PROFILE FORM. Ug5.24
SOIL TAXONOMY UNIT. Typic Pellustert
FAO UNESCO UNIT: Pellic Vertisol

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL. 0.20 m
HORIZONTAL INTERVAL: 7 m
SURFACE COARSE FRAGMENTS- Very few
COMPONENT OF MICRORELIEF SAMPLED: Mound

SUBSTRATE MATERIAL: Unconsolidated substrate materials
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE: 0.4 %
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE: Plain

VEGETATION
STRUCTURAL FORM:
DOMINANT SPECIES: Eucalyptus alba, Acacia bidwillii

ANNUAL RAINFALL-

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking, self mulching

HORIZON	DEPTH	DESCRIPTION
A	0 to 06 m	Brownish black (10YR3/1), few fine faint brown mottles, medium clay; strong 5-10mm angular blocky; moderately weak. Abrupt to-
B21	06 to .50 m	Brownish grey (10YR4/1), medium heavy clay; few subangular unspecified coarse fragments, strong 10-20mm angular blocky, very firm Clear to-
B22	.50 to .70 m	Brownish grey (10YR4/1), medium heavy clay, few subangular unspecified coarse fragments, strong 10-20mm lenticular, very firm, very few manganiferous concretions, very few carbonate concretions. Gradual to-
B23	.70 to 1 10 m	Yellowish grey (2.5Y4/1), medium heavy clay; few subangular unspecified coarse fragments, strong 10-20mm lenticular, very firm, very few manganiferous concretions, very few carbonate concretions. Gradual to-
B24	1.10 to 1.50 m	Greyish yellow (2.5Y6/2), medium clay, few subangular unspecified coarse fragments; strong 10-20mm angular blocky, moderately firm, very few manganiferous concretions, very few carbonate concretions. Clear to-
B25kn	1.50 to 1.70 m	Greyish yellow (2.5Y7/2), medium clay, many subangular unspecified coarse fragments, strong 10-20mm angular blocky; moderately firm, few carbonate soft segregations, few manganiferous soft segregations.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	1/3b	15b	Disp.Ratio R1	R2
metres		mS/cm @105C	%	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C				
Bulk .10	6.6	.03	.002																	
.06	6.4	.02	.002	24	23	16	36	30	0.2	8.7	.57	.42	.030	0.60	.021	3.6	29	15	.69	
.30	7.5	.03	.003	18	18	14	45	31	15	14	1.4	.15	.017	0.52	.008	3.9	33	18	79	
.60	9.1	.14	.014	18	19	14	45	33	15	16	2.8	.22	.015	0.51	.006	3.9	33	18	.91	
90	9.1	.40	.066	20	20	16	42	30	11	17	4.5	.14	.014	0.55	.032	4.0	32	17	.84	
1.20	9.0	.67	.090	21	23	16	38	29	9.9	16	5.3	.21	.013	0.69	.038	3.6				
1.50	9.0	.64	.090																	

Depth	Org.C (W&B)	Tot.N	Extr. Phosphorus Acid	Bicarb.	Rep. K	DTPA-extr. Fe	Mn	Cu	Zn
metres	% @ 105C	% @ 105C	ppm @ 105C		m.eq% @105C	ppm @ 105C			
Bulk .10	1.8	.13	10	8	.54	70	29	1.9	1.7

APPENDIX III (Continued)

SOIL TYPE: 2Dya
SITE NO: S09
A M G. REFERENCE: 525 690 mE 7 806 680 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Dy2.33
SOIL TAXONOMY UNIT: Typic Natrustalf
FAO UNESCO UNIT: Solodic Planosol

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: 0.05 m
HORIZONTAL INTERVAL. 10 m
SURFACE COARSE FRAGMENTS: Very few

SUBSTRATE MATERIAL. Unconsolidated substrate materials
CONFIDENCE SUBSTRATE IS PARENT MATERIAL

SLOPE. 0.2 %
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE. Plain

VEGETATION
STRUCTURAL FORM.
DOMINANT SPECIES: Eucalyptus alba, Eucalyptus tessellaris, Grevillea striata

ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .08 m	Dark brown (10YR3/3), common fine distinct brown mottles, clay loam,fine sandy, massive, moderately weak Abrupt to-
A2sb	.08 to .08 m	Dark brown (10YR3/3), dry sporadically bleached, clay loam,fine sandy, massive, moderately weak. Abrupt to-
B21t	.08 to .70 m	Dark greyish yellow (2 5Y4/2), medium clay, strong 20-50mm lenticular parting to 5-10mm angular blocky, many clay skins; very firm, very few manganiferous concretions. Clear to-
B22t	.70 to 1.10 m	Dull yellowish brown (10YR4/3); medium clay, strong 20-50mm lenticular parting to 5-10mm angular blocky, many clay skins, very firm; very few manganiferous concretions, very few carbonate concretions Clear to-
D	1.10 to 1.50 m	Dull brown (7.5YR5/4), light medium clay, strong 20-50mm lenticular parting to 5-10mm angular blocky, very firm, very few manganiferous concretions, very few carbonate concretions

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS FS S C	Exch Cations CEC Ca Mg Na K	Total Elements P K S	Moistures ADM 1/3b 15b	Disp Ratio R1 R2
metres		mS/cm	%	%	m.eq/100g	%	%	
		@105C		@ 105C	@ 105C	@ 80C	@ 105C	
Bulk .10	6.6	.04	.006					
.08	6.0	.06	.005	15 42 18 24	14 3.1 5.0 .67 .76	.022 0.92 .014	1.7 21 08	.60
.30	7.6	.25	.036	7 20 14 59	31 8.3 15 4.7 .24	.018 0.96 .054	4 2 38 20	.88
.60	8.7	.50	.088	6 29 17 48	24 6.0 13 6.5 .19	.013 0.98 .016	3.4 34 17	.96
.90	9.3	.62	.088	8 24 19 49	27 7.5 13 8.3 .26	.016 1.03 .024	3.6 37 19	.99
1.20	9.7	.38	.045	7 25 18 48	28 6.2 13 9.2 .28	.018 1.09 .024	3.6	
1.50	9.3	.97	.118					

Depth	Org.C (W&B)	Tot.N	Extr Acid	Phosphorus Bicarb.	Rep. K	DTPA-extr. Fe Mn Cu Zn
metres	%	%	ppm	m.eq%	ppm	
	@ 105C	@ 105C	@ 105C	@105C	@ 105C	
Bulk .10	1.1	.18	6 6	.45	75 23 1.7 0.3	

SOIL TYPE: 1Dyc
SITE NO: S10
A M G REFERENCE: 532 730 mE 7 807 990 mN ZONE 55

GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Dy2.33
SOIL TAXONOMY UNIT: Typic Natrustalf
FAO UNESCO UNIT: Solodic Planosol

SURFACE COARSE FRAGMENTS. Very few

SUBSTRATE MATERIAL. Unconsolidated substrate materials
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE: 1 %
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE: Plain

VEGETATION
STRUCTURAL FORM:
DOMINANT SPECIES: Eucalyptus papuana, Grevillea striata

ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .08 m	Brownish black (10YR3/2), few fine faint brown mottles, clay loam, massive; dry moderately firm. Abrupt to-
A2sb	.08 to .08 m	Brownish black (10YR3/2) moist, dry sporadically bleached, common medium distinct brown mottles, clay loam; massive, dry moderately firm. Abrupt to-
B21t	.08 to .20 m	Dark greyish yellow (2.5Y4/2), few fine faint brown mottles, medium clay; few subangular unspecified coarse fragments, strong 10-20mm prismatic parting to strong 5-10mm angular blocky, moist very firm, very few manganiferous concretions. Clear to-
B22tk	.20 to .70 m	Dark greyish yellow (2.5Y4/2), medium heavy clay, few subangular unspecified coarse fragments, strong 10-20mm angular blocky parting to strong 5-10mm angular blocky, moist very firm, few carbonate concretions, few manganiferous concretions, few carbonate soft segregations. Gradual to-
B23t	.70 to 1.10 m	Dark greyish yellow (2.5Y5/2), medium clay; few subangular unspecified coarse fragments, strong 20-50mm lenticular parting to strong 10-20mm angular blocky, moderately moist very firm, very few carbonate concretions, few manganiferous soft segregations, very few carbonate soft segregations, few manganiferous concretions. Gradual to-
B24t	1.10 to 1.50 m	Dull yellowish orange (10YR6/3), medium clay, few subangular unspecified coarse fragments; strong 20-50mm lenticular parting to strong 10-20mm angular blocky, moderately moist very firm, very few carbonate concretions, few manganiferous concretions, very few carbonate soft segregations, few manganiferous soft segregations.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS FS S C	Exch. Cations CEC Ca Mg Na K	Total Elements P K S	Moistures ADM 1/3b 15b	Disp.Ratio R1 R2
metres		mS/cm	%	%	m.eq/100g	%	%	
		@105C		@ 105C	@ 105C	@ 80C	@ 105C	
Bulk .10	6.6	.02	.036					
.08	6.8	.02	.012	41 33 10 14	13 4.5 3.6 .41 .13	.013 0.24 .008	1.5 15 06	.64
.30	9.5	.25	.140	27 16 11 42	31 14 13 6.1 .10	.017 0.25 .029	4 2 34 18	.85
.60	9.2	.97	.133	22 23 14 41	35 11 13 9.7 .10	.012 0.26 .039	3.6 35 18	.99
.90	9.2	.72	.127	19 21 4 45	34 11 14 11 .19	.012 0 38 .023	3.9 36 19	.99
1.20	8.5	.75	.139	24 21 13 42	32 10 12 10 .51	.010 0.56 .016	3.9	
1.50	8.6	.21	.048					

Depth	Org.C (W&B)	Tot.N	Extr Acid	Phosphorus Bicarb.	Rep. K	DTPA-extr. Fe Mn Cu Zn
metres	%	%	ppm	m.eq%	ppm	
	@ 105C	@ 105C	@ 105C	@105C	@ 105C	
Bulk .10	0.7	.05	3 3	.15	41 35 0.9 0.1	

APPENDIX III (Continued)

SOIL TYPE: 3Uga8
SITE NO: S11
A M G. REFERENCE: 530 480 mE 7 808 440 mN ZONE 55

GREAT SOIL GROUP: Black earth
PRINCIPAL PROFILE FORM: Ug5 16
SOIL TAXONOMY UNIT: Entic Pellustert
FAO UNESCO UNIT: Pellic Vertisol

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: 0.20 m
HORIZONTAL INTERVAL: 6 m
SURFACE COARSE FRAGMENTS Very few
COMPONENT OF MICRORELIEF SAMPLED. Mound

SUBSTRATE MATERIAL. Unconsolidated substrate materials
CONFIDENCE SUBSTRATE IS PARENT MATERIAL

SLOPE. 0.2 %
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE- Plain

VEGETATION
STRUCTURAL FORM: Closed tussock grassland
DOMINANT SPECIES: Parkinsonia aculeata, Cryptostegia grandiflora, Ophiurous exaltatus, Bothriochloa species

ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY. Periodic cracking, self mulching

HORIZON	DEPTH	DESCRIPTION
A11	0 to .02 m	Brownish black (10YR3/1), medium clay, strong, very few carbonate concretions. Abrupt to-
A12	.02 to 08 m	Brownish black (10YR3/1), medium heavy clay, few subangular unspecified coarse fragments, strong 5-10mm angular blocky, moderately moist, very few manganiferous concretions, very few carbonate concretions. Abrupt to-
B21	.08 to .40 m	Brownish grey (10YR4/1), medium heavy clay, few subangular unspecified coarse fragments, strong 10-20mm angular blocky parting to 5-10mm angular blocky, moist, very few manganiferous concretions, very few carbonate concretions. Gradual to-
B22	.40 to .70 m	Brownish grey (10YR4/1), medium heavy clay, few subangular unspecified coarse fragments, strong 10-20mm lenticular parting to 5-10mm lenticular, many clay skins, moist, very few manganiferous concretions, very few carbonate soft segregations, very few carbonate concretions Gradual to-
B23	70 to 1 00 m	Brownish grey (10YR4/1), medium heavy clay, few subangular unspecified coarse fragments, strong 10-20mm lenticular parting to 5-10mm lenticular, many clay skins, moist, very few manganiferous concretions, very few carbonate soft segregations, very few carbonate concretions. Gradual to-
B24k	1.00 to 1.50 m	Brownish grey (10YR5/1), medium heavy clay, few subangular unspecified coarse fragments; strong 10-20mm lenticular parting to 5-10mm lenticular, many clay skins,moderately moist; few manganiferous concretions, very few carbonate soft segregations, few carbonate concretions.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	1/3b	15b	Disp.Ratio R1	R2
metres		mS/cm @105C	%	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C				
Bulk .10	6.5	.03	.003																	
.10	7.1	.03	.003	26	11	17	49	41	23	15	.38	.62	0.21	0.44	.015	5.2	34	18	.71	
.30	9.0	.06	.003	29	7	16	50	40	24	15	.62	.17	.016	0.40	.006	5.4	33	19	.69	
.60	9.3	09	.002	32	5	17	49	40	20	18	2.1	.14	.020	0.41	.006	5.3	35	19	.83	
.90	9.4	.17	.008	31	6	14	49	39	18	21	3.8	.17	015	0.38	.005	5.1	37	19	.87	
1.20	9.3	.35	.044	34	9	13	46	39	14	22	4.9	.16	.015	0.32	.012	4.7				
1.50	9.1	.56	.087																	

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. Acid ppm @ 105C	Phosphorus Bicarb. ppm @ 105C	Rep. K m.eq% @105C	DTPA-extr. Fe ppm @ 105C	Mn	Cu	Zn
Bulk .10	1.5	.11	11	9	.54	73	28	1.9	0.6

SOIL TYPE: 5Uga
SITE NO: S12
A M G. REFERENCE: 531 640 mE 7 815 040 mN ZONE 55

GREAT SOIL GROUP: Black earth
PRINCIPAL PROFILE FORM: Ug5.14
SOIL TAXONOMY UNIT: Typic Pellustert
FAO UNESCO UNIT: Pellic Vertisol

SURFACE COARSE FRAGMENTS: Very few gravel

SUBSTRATE MATERIAL.
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE:
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM: Open woodland
DOMINANT SPECIES: Eucalyptus papuana, Eucalyptus alba, Dicanthium species

ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY. Periodic cracking, self mulching

HORIZON	DEPTH	DESCRIPTION
A11	0 to .02 m	Black (10YR1.7/1); medium heavy clay, strong <2mm granular; moderately firm. Abrupt to-
A12	.02 to .08 m	Black (10YR1.7/1), medium heavy clay; strong 10-20mm angular blocky, moderately strong. Clear to-
B21	.08 to .48 m	Black (7 5YR1.7/1), medium heavy clay; strong 20-50mm angular blocky parting to strong 10-20mm angular blocky, moderately strong. Gradual to-
B23	.48 to .60 m	Black (7.5YR1.7/1); medium heavy clay, strong 50-100mm lenticular parting to 5-10mm lenticular, moderately strong. Clear to-
B24	.60 to .75 m	Black (10YR1.7/1), medium heavy clay, strong 50-100mm lenticular parting to 5-10mm lenticular, moderately strong; few carbonate concretions. Gradual to-
BC	.75 to .88 m	Grey (5Y4/1); strong 20-50mm prismatic parting to 10-20mm angular blocky; moderately strong, many carbonate soft segregations. Gradual to-
C	.88 to 1.20 m	Abundant weathered diorite.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	1/3b	15b	Disp.Ratio R1	R2
metres		mS/cm @105C	%	% @ 105C				m.eq/100g @ 105C					% @ 80C			% @ 105C				
Bulk .10	6.4	.03	.002																	
.10	6.3	.05	.003	8	20	20	52	53	21	20	.70	.34	.033	0.15	.019	5.4	41	23	.67	
.30	7.1	.05	.002	6	21	17	55	54	26	22	1.7	.21	.018	0.14	.010	5.8	45	25	.79	
.60	7.9	.22	.030	7	18	18	55	54	27	23	3.3	.20	.018	0.14	.011	6.3	46	26	.77	
.90	8.9	.37	.037	32	28	10	27	33	18	16	3.4	.16	.034	0.28	.009	4.3	30	15	.87	
1.20	9.5	.33	.025	39	39	7	12	23	11	10	5.9	.14	.043	0.19	.006	4.0				

Depth	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. Acid ppm @ 105C	Phosphorus Bicarb. ppm @ 105C	Rep. K m.eq% @105C	DTPA-extr. Fe ppm @ 105C	Mn	Cu	Zn
Bulk .10	1.2	.09	23	6	.20	51	28	1.7	0.3
.10	1.6	.11	19	11	.21				

APPENDIX III (Continued)

SOIL TYPE: 1Ugf
SITE NO: S13
A M.G. REFERENCE: 531 200 mE 7 814 730 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Ug3.2
SOIL TAXONOMY UNIT: Entic Chromustert
FAO UNESCO UNIT: Pellic Vertisol

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: 0.15 m
HORIZONTAL INTERVAL: 12 m
COMPONENT OF MICRORELIEF SAMPLED: Mound

SUBSTRATE MATERIAL: Unconsolidated substrate materials
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE:
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM Open woodland
DOMINANT SPECIES: Eucalyptus alba, Grevillea striata

ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking,self mulching

HORIZON	DEPTH	DESCRIPTION
A11	0 to .01 m	Light medium clay, moderate <2mm granular, moderately firm.
A12:b	01 to .12 m	Yellowish grey (2 5Y5/1), dry sporadically bleached, common fine distinct brown mottles, light medium clay, moderate 20-50mm angular blocky, moderately strong
B21	.12 to .30 m	Greyish yellow-brown (10YR4/2), few fine distinct brown mottles, medium clay, few subangular coarse fragments, strong 50-100mm prismatic parting to strong 20-50mm angular blocky, moderately strong, very few manganiferous concretions
B22	.30 to 70 m	Brownish grey (10YR4/1); medium clay, few subangular coarse fragments, strong 20-50mm lenticular parting to strong 10-20mm lenticular, moderately strong
B23	.70 to .90 m	Brownish grey (10YR4/1), medium clay, few subangular coarse fragments, strong 20-50mm lenticular parting to strong 10-20mm lenticular, moderately strong, very few carbonate concretions.
B24	.90 to 1 15 m	Dark greyish yellow (2.5Y5/2), medium clay, few subangular coarse fragments, strong 20-50mm lenticular parting to strong 10-20mm lenticular, moderately strong, very few carbonate concretions.
2B25n?	1.15 to 1.50 m	Dull yellow (2 5Y6/4); medium clay, strong 20-50mm lenticular parting to strong 10-20mm lenticular, moderately strong; few feldspar segregations, very few manganiferous concretions, very few manganiferous soft segregations.
2BC?	1.50 to 1.80 m	Dull yellow (2.5Y6/4), medium clay, strong 20-50mm lenticular parting to strong 10-20mm lenticular, moderately strong, moderate saprolite and feldspar segregations.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	1/3b	15b	Disp.Ratio R1	R2
metres		mS/cm	%	%				m.eq/100g					%				%			
		@105C		@ 105C				@ 105C					@ 80C				@ 105C			
Bulk .10	5.7	.08	006																	
.12	5.5	.04	.004	25	34	15	27	14	3.6	4.7	.73	.19	.017	0.07	.011	2.2	19	09	.67	
.30	6.9	.16	.024	13	25	18	40	23	6.4	11	2.3	.20	.009	0.05	.007	1.8	29	15	.93	
.60	7.8	.61	.082	14	24	18	46	29	8.8	15	5.4	.15	.008	0.04	.007	3.1	32	18	.99	
.90	8.5	.79	.119	14	19	20	47	31	8.9	17	7.0	.14	.009	0.05	.006	3.5	32	19	.99	
1.15	8.8	.74	.072	16	20	17	45	33	8.7	17	7.4	.16	.023	0.05	.003	3.8				
1.50	9.1	.59	.064																	

Depth	Org.C (W&B)	Tot.N	Extr. Phosphorus Acid	Bicarb.	Rep. K	DTPA-extr. Fe	Mn	Cu	Zn
metres	%	%	ppm		m.eq%	ppm			
	@ 105C	@ 105C	@ 105C		@105C	@ 105C			
Bulk .10	1.1	.10	8	9	.42	169	72	1.5	0.5
12	.57	.05	3	3	.11				

SOIL TYPE: 1Ugf
SITE NO: S14
A M G. REFERENCE: 531 230 mE 7 814 730 mN ZONE 55

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Ug3.2
SOIL TAXONOMY UNIT: Entic Pellustert
FAO UNESCO UNIT. Pellic Vertisol

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: 0.15 m
HORIZONTAL INTERVAL: 12 m
COMPONENT OF MICRORELIEF SAMPLED: Mound

SUBSTRATE MATERIAL: Unconsolidated substrate materials
CONFIDENCE SUBSTRATE IS PARENT MATERIAL.

SLOPE:
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM:
DOMINANT SPECIES

ANNUAL RAINFALL.

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY Periodic cracking, self mulching

HORIZON	DEPTH	DESCRIPTION
A11	0 to .04 m	Brownish grey (10YR4/1); medium clay; weak <2mm granular, moderately weak. Abrupt to-
A12sb	.04 to .15 m	Brownish grey (10YR4/1), dry sporadically bleached; common medium distinct brown mottles, light medium clay; moderate 20-50mm angular blocky parting to 10-20mm angular blocky; moderately strong. Abrupt to-
B21	.15 to .35 m	Brownish grey (10YR4/1); few fine distinct brown mottles; medium clay; many subangular unspecified coarse fragments; strong 50-100mm prismatic parting to strong 20-50mm angular blocky, moderately strong. Clear to-
B22	.35 to .50 m	Brownish grey (10YR4/1), medium clay; few subangular unspecified coarse fragments, strong 20-50mm angular blocky parting to strong 10-20mm angular blocky; moderately strong. Clear to-
B23	50 to .80 m	Brownish grey (10YR4/1); medium clay; few subangular unspecified coarse fragments, strong 20-50mm lenticular parting to strong 10-20mm lenticular; moderately strong. Clear to-
B24k	.80 to 1.00 m	Yellowish brown (2.5Y5/3), medium clay, few subangular unspecified coarse fragments, strong 20-50mm lenticular parting to strong 10-20mm lenticular; many clay skins, moderately strong; few carbonate concretions. Clear to-
B25n	1.00 to 1.50 m	Yellowish brown (2.5Y5/3); medium clay, few subangular unspecified coarse fragments; strong 20-50mm lenticular parting to strong 10-20mm lenticular, many clay skins, moderately strong, few manganiferous soft segregations.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM	1/3b	15b	Disp.Ratio R1	R2
metres		mS/cm	%	%				m.eq/100g					%				%			
		@105C		@ 105C				@ 105C					@ 80C				@ 105C			
Bulk .10	5.2	.05	.004																	
.04	5.0	.10	.012	12	18	21	47	35	5.0	6.7	.80	.54	.053	0.17	033	4.0	36	18	.46	
.15	5.2	.03	.002																	
.30	5.6	.09	.013	19	24	17	39	25	6.5	7.7	1.7	.21	.023	0.07	.004	2.8	29	15	.94	
.60	6.1	.59	.066	15	20	19	43	28	7.1	9.9	4.3	.18	.016	0.07	.006	3.0	31	19	.99	
.90	7.9	.88	.088	15	20	17	47	31	9.4	15	7.0	.20	.014	0.06	.003	4.0			.99	
1.20	8.4	.90	.090	10	21	17	50	34	0.1	17	8.3	.20	.016	0.07	.002	4.2				
1.50	8.5	.81	.083																	

Depth	Org.C (W&B)	Tot.N	Extr. Phosphorus Acid	Bicarb.	Rep. K	DTPA-extr. Fe	Mn	Cu	Zn
metres	%	%	ppm		m.eq%	ppm			
	@ 105C	@ 105C	@ 105C		@105C	@ 105C			
Bulk .10	1.0	.08	10	18	.20	265	113	2.8	0.8
. 4	3.0	.25	19	46	.44				

APPENDIX III (Continued)

SOIL TYPE: 5Ugb
SITE NO: S15
A M G. REFERENCE: 530 190 mE 7 815 050 mN ZONE 55

GREAT SOIL GROUP: Black earth
PRINCIPAL PROFILE FORM: Ug5.12
SOIL TAXONOMY UNIT: Typic Pellustert
FAO UNESCO UNIT: Pellic Vertisol
COMPONENT OF MICRORELIEF SAMPLED: Mound

SUBSTRATE MATERIAL: Diorite
CONFIDENCE SUBSTRATE IS PARENT MATERIAL.

SLOPE: 2 %
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE.

VEGETATION
STRUCTURAL FORM. Open woodland
DOMINANT SPECIES: Eucalyptus papuana, Eucalyptus drepanophylla, Eucalyptus alba, Heteropogon contortus, Dicanthium species

ANNUAL RAINFALL·

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking, self mulching

HORIZON	DEPTH	DESCRIPTION
A11	0 to .01 m	Medium clay, weak <2mm granular, dry moderately weak. Abrupt to-
A12	.01 to .10 m	Black (10YR1.7/1), medium clay, strong 20-50mm angular blocky parting to 5-10mm angular blocky, dry moderately strong. Abrupt to-
B21	.10 to .35 m	Brownish black (2 5YJ/1), medium heavy clay, few angular unspecified coarse fragments, strong 20-50mm angular blocky parting to 10-20mm angular blocky, dry moderately strong, very few manganiferous concretions Clear to-
B22	.35 to .80 m	Brownish black (2 5YJ/1), medium heavy clay, few angular unspecified coarse fragments, few subangular unspecified coarse fragments, strong 20-50mm lenticular parting to 10-20mm lenticular, many clay skins; dry moderately strong, very few carbonate concretions Clear to-
BCk	80 to .90 m	Dull yellowish brown (10YR4/3), light clay, strong 10-20mm angular blocky parting to 5-10mm angular blocky; dry moderately strong, few carbonate soft segregations, few carbonate concretions Clear to-
C	.90 to 1.08m	Abundant weathered diorite

Depth (metres)	1:5 Soil/Water pH	EC mS/cm @105C	Cl % @105C	Particle Size CS FS S C %	CEC	Exch. Cations Ca Mg Na K m.eq/100g @ 105C	Total Elements P % @ 80C	K %	S %	Moistures ADM 1/3b @ 105C	15b %	Disp.Ratio R1	R2
Bulk .10	6.2	.04	.003										
.10	6.2	.02	.001	19 23 11 43	33	16 8.6 .26 .14	.031	0.10	.023	4.1	29 17	.45	
.30	6.7	.02	.001	19 23 10 47	33	18 9.7 .50 .21	.021	0.09	.020	4 2	31 19	.54	
.60	7.4	.04	.002	20 25 11 43	32	19 10 .60 .19	.019	0 10	.011	4.4	30 18	.63	
.90	8.6	.14	.002	22 36 12 29	29	18 10 .63 .17	052	0.57	.011	3.2	25 13	.59	
1.10	8.9	.11	.002	52 23 5 5	10	6.7 4.6 .41 .10	.093	1.23	.004	1.8	10 05	99	

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. Phosphorus Acid ppm @ 105C	Bicarb.	Rep. K m.eq% @105C	DTPA-extr. Fe Mn Cu Zn ppm @ 105C
Bulk .10	1.5	.10	8	6	.24	69 52 1.9 0 4
.10	1.1	.10	4	5	.16	

SOIL TYPE: 6Dbb
SITE NO: S16
A M G REFERENCE: 527 640 mE 7 814 550 mN ZONE 55

GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Dy2.43
SOIL TAXONOMY UNIT: Udic Natrustalf
FAO UNESCO UNIT: Solodic Planosol

SUBSTRATE MATERIAL: Unconsolidated substrate materials
CONFIDENCE SUBSTRATE IS PARENT MATERIAL.

SLOPE:
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM:
DOMINANT SPECIES: Eucalyptus alba, Acacia bidwillii, Carissa ovata

ANNUAL RAINFALL.

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A1	0 to .15 m	Brownish grey (7.5YR4/1) moist, few fine faint brown mottles, clay loam, moderate 5-10mm angular blocky, very firm.
A2cb	.15 to .30 m	Brownish grey (7.5YR5/1) moist, light brownish grey (7.5YR7/1) dry, conspicuously bleached, clay loam; moderate 5-10mm angular blocky; very firm.
B21t	.30 to .80 m	Brownish grey (10YR4/1) moist, light medium clay, strong 50-100mm prismatic parting to strong 10-20mm angular blocky, moderately strong, very few manganiferous concretions.
B22t?	.80 to 1.00 m	Greyish brown (7.5YR4/2) moist, light medium clay, strong 10-20mm angular blocky, moderately strong, very few carbonate concretions.
B23tk	1.00 to 1.30 m	Brown (7.5YR4/3) moist, light medium clay, strong 10-20mm angular blocky, moderately strong; few manganiferous nodules, few carbonate concretions
D1	1.30 to 1.85 m	Dull reddish brown (5YR4/4) moist, medium clay, strong 50-100mm prismatic parting to strong 5-10mm angular blocky, common argillans, few clay skins, moderately strong; few manganiferous nodules.
D2	1.85 to 2.10 m	Bright brown (7.5YR5/6) moist, fine sandy clay, strong 20-50mm prismatic parting to strong 10-20mm prismatic, moderately strong.

Depth (metres)	1:5 Soil/Water pH	EC mS/cm @105C	Cl % @105C	Particle Size CS FS S C % @ 105C	CEC	Exch. Cations Ca Mg Na K m.eq/100g @ 105C	Total Elements P % @ 80C	K %	S %	Moistures ADM 1/3b @ 105C	15b %	Disp.Ratio R1	R2
Bulk .10	6.2	.06	.004										
.10	6.1	.04	.003	6 25 41 29	28	8.7 7.9 .26 .87	.077	1.68	.023	3.0	35 14	.71	
.30	6.1	.02	.001	4 35 37 30	25	9.8 7.4 .61 .39	.043	1.64	.010	2.9	28 13	.69	
.60	7.9	.11	.010	2 27 24 50	32	16 13 2.4 .33	.028	1.44	.010	3.4	33 19	.90	
.90	8.5	.25	.022	3 29 24 49	31	16 14 3.5 .31	.038	1.46	.011	3.4	33 18	.90	
1.20	8.6	.25	.016	4 41 24 33	22	11 9.3 2.3 .38	.036	1.60	005	2.4	27 15	.98	
1.50	8.3	.18	.017	2 35 19 42	19	8.8 7 5 2.0 .38	.030	1.52	.005	2.5	28 17	.89	
2.00	8.1	.11	.011	1 48 20 31	17	9.0 7.6 1.8 .33	.033	1.62	.004	2.2	25 13	.90	

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. Phosphorus Acid ppm @ 105C	Bicarb.	Rep. K m.eq% @105C	DTPA-extr. Fe Mn Cu Zn ppm @ 105C
Bulk .10	2.2	.15	65	36	.74	128 56 3.1 3.8
.10	2.2	.16	73	41	.80	

APPENDIX III (Continued)

SOIL TYPE: 5Ugc
SITE NO: S17
A M G. REFERENCE: 530 610 mE 7 812 040 mN ZONE 55

GREAT SOIL GROUP- No suitable group
PRINCIPAL PROFILE FORM: Ug2.
SOIL TAXONOMY UNIT: Typic Pellustert
FAO UNESCO UNIT: Pellic Vertisol

TYPE OF MICRORELIEF: Linear gilgai
VERTICAL INTERVAL: 0.10 m
HORIZONTAL INTERVAL. 12 m
COMPONENT OF MICRORELIEF SAMPLED. Depression

SUBSTRATE MATERIAL.
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE: 1 %
LANDFORM ELEMENT TYPE.
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM: Open woodland
DOMINANT SPECIES- Eucalyptus papuana, Eucalyptus alba, Heteropogon contortus

ANNUAL RAINFALL:

PROFILE MORPHOLOGY
CONDITION OF SURFACE SOIL WHEN DRY Periodic cracking, self mulching

HORIZON	DEPTH	DESCRIPTION
A11	0 to .01 m	Brownish black (10YR3/1) moist; light medium clay, massive, moderately weak. Abrupt to-
A12	.01 to 12 m	Brownish black (10YR3/1) moist, light medium clay, moderate 5-10mm angular blocky, moderately firm Abrupt to-
A2cb	.12 to 18 m	Black (10YR2/1) moist, yellowish grey (2.5YR6/1) dry, conspicuously bleached, light medium clay, moderate 5-10mm angular blocky, moderately weak. Abrupt to-
B21	18 to .50 m	Brownish black (2 5YJ/1) moist, medium heavy clay, few subangular unspecified coarse fragments, strong 50-100mm prismatic parting to 10-20mm angular blocky, moderately strong. Clear to-
B22	50 to .75 m	Greyish yellow-brown (10YR4/2) moist, medium heavy clay, few subangular unspecified coarse fragments, strong 20-50mm lenticular parting to 10-20mm lenticular, many clay skins, moderately strong, very few carbonate concretions Clear to-
BCk	75 to 90 m	Dull yellowish brown (10YR5/3) moist, light medium clay, strong 20-50mm lenticular parting to 10-20mm lenticular, many clay skins, moderately strong, many saprolite segregations, few carbonate concretions. Clear to-
C	.90 to 1.20 m	Abundant weathered diorite.

Depth metres	1 5 Soil/Water pH	EC mS/cm @105C	Cl %	Particle Size CS FS % @ 105C	S %	C %	Exch. Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K	Total Elements P % @ 80C	K %	S %	Moistures ADM 1/3b % @ 105C	15b	Disp.Ratio R1	R2
Bulk .10	6.1	.03	.002															
.12	5.8	.03	.002	27	21	20	27	30	8.8	7.4	.46	.25	.027	0.11	.017	2.8	13	.67
.18	6.0	.04	.004					22	7.0	5.7	.90	.17						
.30	6.9	.28	.045	23	19	19	36	26	9.5	9.1	2.9	.20	.012	0.09	.013	2.9	29 17	.88
.60	8.3	.86	.089	21	14	15	49	35	13	16	6.9	.22	.012	0.07	.021	3.7	39 22	.99
.90	9.1	.93	.119	35	22	12	31	31	10	13	8.4	.19	.064	0.16	.007	3.4	30 16	.99
1.10	9.4	.53	.065	49	34	6	11	17	7.2	8.2	6.3	.17	.136	0.23	.082	2.5		

Depth metres	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. Phosphorus Acid ppm @ 105C	Bicarb. ppm @ 105C	Rep. K m.eq% @105C	DTPA-extr. Fe ppm @ 105C	Mn	Cu	Zn
Bulk .10	.68	.07	6	5	.17	84	72	1.4	0.3
.12	1.2	.07	5	5	.14				

SOIL TYPE: 5Dyf
SITE NO: S18
A M G REFERENCE: 530 610 mE 7 812 060 mN ZONE 55
GREAT SOIL GROUP: Solodized solonetz
PRINCIPAL PROFILE FORM: Dy2.33
SOIL TAXONOMY UNIT. Typic Natrustalf
FAO UNESCO UNIT: Solodic Planosol

TYPE OF MICRORELIEF: Linear gilgai
VERTICAL INTERVAL: 0.10 m
HORIZONTAL INTERVAL. 12 m
COMPONENT OF MICRORELIEF SAMPLED Shelf

SUBSTRATE MATERIAL:
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:
SLOPE: 1 %
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM:
DOMINANT SPECIES: Eucalyptus papuana, Eucalyptus alba, Bothriochloa species, Aristida species

ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY. Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1	0 to .10 m	Dull yellowish brown (10YR4/3) moist, few fine distinct brown mottles, clay loam, sandy, massive. Abrupt to-
A2sb	.10 to 15 m	Light yellowish orange (10YR8/3), dry sporadically bleached, few fine distinct brown mottles; clay loam, sandy, massive. Abrupt to-
B21tn	.15 to .20 m	Dull yellowish brown (10YR4/3) moist, common fine distinct brown mottles; medium clay, few subangular unspecified coarse fragments; strong 100-200mm columnar parting to 10-20mm angular blocky, few manganiferous concretions. Abrupt to-
B22t	.20 to .40 m	Dark greyish yellow (2.5Y4/2) moist, medium clay; few subangular unspecified coarse fragments, strong 100-200mm columnar parting to 10-20mm angular blocky, very few manganiferous concretions, very few carbonate concretions. Clear to-
B23tk	.40 to .70 m	Dull yellowish brown (10YR5/4) moist; medium clay; strong 20-50mm angular blocky parting to 10-20mm angular blocky, few clay skins; few manganiferous concretions, few carbonate soft segregations few carbonate concretions. Clear to-
B24tkn	.70 to .90 m	Dull yellowish brown (10YR5/4) moist, medium clay; strong 20-50mm angular blocky parting to 10-20mm angular blocky, few clay skins; few manganiferous concretions, few carbonate soft segregations few carbonate concretions. Clear to-
BCk	.90 to .95 m	Dull yellowish brown (10YR5/4) moist; light medium clay; strong 20-50mm angular blocky parting to 10-20mm angular blocky; many carbonate concretions, many unspecified rock segregations. Clear to-
C	.95 to 1.50 m	Abundant weathered unspecified rock.

Depth metres	1:5 Soil/Water pH	EC mS/cm @105C	Cl %	Particle Size CS FS % @ 105C	S %	C %	Exch. Cations CEC m.eq/100g @ 105C	Ca	Mg	Na	K	Total Elements P % @ 80C	K %	S %	Moistures ADM 1/3b % @ 105C	15b	Disp.Ratio R1	R2
Bulk .10	6.0	.02	.002															
.10	6.0	.02	.002	35	28	14	20	9	3.4	2.8	.35	.20	.018	0.10	.009	1.2	05	.20
.20	6.9	.16	.025					19	6.1	6.2	2.3	.25	.012	0.05	.020			
.30	7.8	.32	.052	26	19	10	42									3.2	30 18	.78
.60	9.1	.97	.113	32	20	13	35	27	8.5	11	7.4	.22	.018	0.07	.027	2.6	30 15	.93
.90	9.0	1.3	.175	26	25	15	35	31	9.5	13	9.6	.20	.035	0.19	.035	3.1	32 17	.94
1.10	9.4	.84	.078	36	30	16	16	28	8.6	11	15	.19				3.1		

Depth metres	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. Phosphorus Acid ppm @ 105C	Bicarb. ppm @ 105C	Rep. K m.eq% @105C	DTPA-extr. Fe ppm @ 105C	Mn	Cu	Zn
Bulk .10	.43	.04	3	3	.10	32	30	0.9	0.1
.10	.36	.03	8	3	.12				

APPENDIX III (Continued)

SOIL TYPE: 5Dra
SITE NO: S19
A.M.G. REFERENCE: 531 020 mE 7 817 310 mN ZONE 55

GREAT SOIL GROUP: Non-calcic brown soil
PRINCIPAL PROFILE FORM: Uf6.31
SOIL TAXONOMY UNIT: Udic Paleustalf
FAO UNESCO UNIT: Chromic Luvisol

SUBSTRATE MATERIAL:
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE: 2 %
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM: Open woodland
DOMINANT SPECIES Eucalyptus drepanophylla, Eucalyptus alba, Eucalyptus dichromophloia, Heteropogon contortus, species Bothriochloa species

ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY: Firm

HORIZON	DEPTH	DESCRIPTION
A1	0 to 20 m	Brownish black (5YR3/1), light clay, moderate 10-20mm angular blocky parting to moderate 5-10mm angular blocky, moderately firm, very few manganiferous concretions, common very fine roots Clear smooth to-
AB	20 to 25 m	Dark reddish grey (2.5YR3/1), dark reddish brown (2.5YR3/4), light medium clay, moderate 10-20mm angular blocky parting to moderate 5-10mm angular blocky, moderately firm, very few manganiferous concretions, common very fine roots. Clear smooth to-
B21t	25 to 60 m	Dark reddish brown (2.5YR3/6); heavy clay, strong 50-100mm prismatic parting to strong 5-10mm angular blocky; very firm; very few manganiferous concretions, few very fine roots Clear smooth to-
B22t	.60 to 1.00 m	Reddish brown (2.5YR4/6), medium clay, strong 20-50mm angular blocky parting to strong 5-10mm angular blocky, very firm; few manganiferous concretions; few very fine roots Clear smooth to-
C	1.00 to 1.10 m	Abundant weathered unspecified rock, few very fine roots

Depth (metres)	1:5 Soil/Water pH	EC mS/cm @105C	Cl %	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P %	K %	S % @ 80C	Moistures ADM 1/3b 15b % @ 105C		Disp Ratio R1	R2
Bulk .10	6.5	.04	.003									
.10	6.2	.03	.002	35 28 14 20	19 8.2 3.6 .25 .33	.058	0.26	.023	1.9	11	.61	
.25	6.2	.01	.001									
.30	6.2	.01	.001	18 18 7 55	20 8 0 4.2 .16 .21	.021	0.28	006	2.7 30	20	.48	
50	6 4	.02	001	10 15 11 63	23 9.1 5 2 .23 .27	.026	0.10	.008	3.8 33	24	.34	
90	6 8	.02	.001	13 23 20 43	36 18 13 .36 .21	.028	0.24	004	5.1 37	22	.58	
1.10	7.1	.02	.001	14 38 20 26	29 17 11 45 .22	.041	0 56	005	3.6			

Depth (metres)	Org.C (W&B) % @ 105C	Tot N % @ 105C	Extr. Phosphorus Acid ppm @ 105C	Bicarb. @ 105C	Rep. K m.eq% @105C	DTPA-extr. Fe ppm @ 105C	Mn	Cu	Zn
Bulk 10	.77	.06	10	8	.39	63	72	1.6	1.0
.10	1.6	.07	7	7	.25				

SOIL TYPE: 1UgdM
SITE NO. S20A
A.M.G. REFERENCE: 528 880 mE 7 812 940 mN ZONE 55

GREAT SOIL GROUP Grey clay
PRINCIPAL PROFILE FORM: Ug5.28
SOIL TAXONOMY UNIT: Entic Chromustert
FAO UNESCO UNIT: Chromic Vertisol

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL 0.25 m
HORIZONTAL INTERVAL: 8 m
COMPONENT OF MICRORELIEF SAMPLED: Mound

SUBSTRATE MATERIAL:
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE:
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM: Woodland
DOMINANT SPECIES. Eucalyptus alba, Eucalyptus tessellaris, Melaleuca viridiflora, Bothriochloa species

ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking, self mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .06 m	Brownish grey (10YR4/1), common fine distinct brown mottles, light medium clay, strong 2-5mm granular, dry very firm.
B21	.06 to .18 m	Dark greyish yellow (2.5Y4/2), few fine distinct yellow mottles, medium heavy clay, very few small pebbles, subrounded quartz, strong 5-10mm subangular blocky; few faint clay skins; moderately moist very strong, very few medium manganiferous nodules. Abrupt to-
B22	18 to .65 m	Dark greyish yellow (2.5Y4/2), few fine faint yellow mottles; medium heavy clay; very few small pebbles, subrounded quartz, strong lenticular parting to 10-20mm subangular blocky, common distinct clay skins, moderately moist very strong, very few medium manganiferous nodules. Clear to-
B23k	.65 to 1.40 m	Dark greyish yellow (2.5Y5/2), few fine faint yellow mottles; medium heavy clay, very few small pebbles, subrounded quartz, strong lenticular parting to 10-20mm subangular blocky, common distinct clay skins, moderately moist very strong; few coarse carbonate nodules, very few medium manganiferous nodules. Abrupt to-
B24k	1.40 to 1.75 m	Dull yellow (2.5Y6/4); medium heavy clay, very few small pebbles, subrounded quartz; strong lenticular parting to 10-20mm subangular blocky, common distinct clay skins; moderately moist very strong; few coarse carbonate nodules, very few medium manganiferous nodules. Gradual to-

Depth (metres)	1:5 Soil/Water pH	EC mS/cm @105C	Cl %	Particle Size CS FS S C % @ 105C	Exch. Cations CEC Ca Mg Na K m.eq/100g @ 105C	Total Elements P %	K %	S % @ 80C	Moistures ADM 1/3b 15b % @ 105C		Disp.Ratio R1	R2
Bulk .10	6.7	.06	.001									
.06	5.8	.03	.001	8 17 22 56	38 7.2 8.6 .44 .44				4.3 31	17	.28	
.20	7.3	.02	.001									
.30	7.8	.03	.001	9 18 17 60	31 14 12 .85 .07				4.1 30	17	.55	
.60	8.6	.09	.003	9 18 17 61	30 12 15 1.8 .07				4.0 31	18	.70	
.90	8.7	.31	.031	9 17 17 60	30 11 17 2.9 .07				3 7 31	18	.71	
1.20	8.7	.56	.065	9 19 13 60	37 9.3 18 4.0 .08				3.6			
1.50	8.6	.69	.090									

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr. Phosphorus Acid ppm @ 105C	Bicarb. @ 105C	Rep. K m.eq% @105C	DTPA-extr. Fe ppm @ 105C	Mn	Cu	Zn
Bulk .10	1.1	.09	3	6	.24	105	41	1.6	0.4
.06	2.3	.19	5	11	.39	252	75	2.4	1.1
.20	0.5	.03	2	2	.10	32	15	0.9	0.2

APPENDIX III (Continued)

SOIL TYPE: 1UgdD
SITE NO: S20B
A M G. REFERENCE: 528 880 mE 7 812 940 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.24
SOIL TAXONOMY UNIT: Entic Pellustert
FAO UNESCO UNIT: Pellic Vertisol

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: 0.25m
HORIZONTAL INTERVAL: 8m
COMPONENT OF MICRORELIEF SAMPLED: Depression

SUBSTRATE MATERIAL:
CONFIDENCE SUBSTRATE IS PARENT MATERIAL

SLOPE:
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM: Woodland
DOMINANT SPECIES: Eucalyptus alba, Eucalyptus tessellaris, Meleuca viridiflora, Bothriochloa species
ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking, self mulching

HORIZON	DEPTH	DESCRIPTION
A1	0 to .05 m	Brownish grey (10YR4/1), common fine distinct brown mottles, light clay, moderate 2-5mm granular, dry moderately firm.
B21	.05 to .40 m	Brownish grey (10YR4/1), few fine distinct brown mottles, medium clay, very few small pebbles, subrounded quartz, strong 5-10mm subangular blocky; moderately moist very strong, very few medium manganiferous nodules. Abrupt to-
B22	.40 to 1.10 m	Brownish grey (10YR4/1), few fine distinct brown mottles, medium clay, very few small pebbles, subrounded quartz, strong lenticular parting to 10-20mm subangular blocky, common distinct clay skins, moderately moist very strong; very few manganiferous nodules. Gradual to-
B23	1.10 to 1.50 m	Dull yellow (2.5Y6/4), medium heavy clay, very few small pebbles, subrounded quartz, strong lenticular parting to 10-20mm subangular blocky, common distinct clay skins, moderately moist very strong, very few medium manganiferous nodules. Gradual to-

Depth (metres)	1:5 Soil/Water pH	EC mS/cm @105C	Cl % @105C	Particle Size CS %	FS %	S %	C % @105C	Exch. Cations CEC m.eq/100g @105C	Ca	Mg	Na	K	Total Elements P % @80C	K	S	Moistures ADM 1/3b 15b % @105C		Disp Ratio R1	R2
Bulk .10	6.0	.03	.001																
.05	5.7	.03	.001	4	17	22	61	33	7.5	9.3	.52	.43				4.1	30	17	.34
.20	6.4	.02	.001																
.30	6.6	.02	.001	5	17	19	60	32	11	12	1.1	.07				3.2	32	19	.68
.60	6.0	.20	.030	6	16	18	60	32	0.2	12	2.2	.08				3.7	32	19	.81
.90	6.4	.50	.078	5	18	17	62	32	0.1	15	3.4	.11				3.8	34	19	.87
1.20	7.7	.73	.109	6	17	16	61	32	10	17	4.3	.10				4.1			
1.50	8.1	.87	.135																

Depth (metres)	Org.C (W&B) % @105C	Tot.N % @105C	Extr. Phosphorus Acid ppm @105C	Bicarb. ppm @105C	Rep. K m.eq% @105C	DTPA-extr. Fe ppm @105C	Mn	Cu	Zn
Bulk .10	1.2	.09	5	12	.52	248	68	3.3	1.2
.05	1.4	.09	4	14	.40	252	72	3.1	1.2
.20	0.5	.04	2	18	.14	153	32	3.1	0.6

SOIL TYPE: 5Uga
SITE NO: S21
A M G. REFERENCE: 531 180 mE 7 811 830 mN ZONE 55

GREAT SOIL GROUP: Black earth
PRINCIPAL PROFILE FORM: Ug5.14
SOIL TAXONOMY UNIT: Typic Pellustert
FAO UNESCO UNIT: Pellic Vertisol

SUBSTRATE MATERIAL:
CONFIDENCE SUBSTRATE IS PARENT MATERIAL.

SLOPE:
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM:
DOMINANT SPECIES: Eucalyptus papuana, Eucalyptus drepanophylla, Heteropogon contortus

ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking, self mulching

HORIZON	DEPTH	DESCRIPTION
A11	0 to .01 m	Black (10YR1.7/1); medium clay; very few small pebbles, subangular unspecified coarse fragments, moderate 5-10mm granular parting to subangular blocky, dry moderately firm.
A12	.01 to .06 m	Brownish black (10YR3/1), medium clay; very few small pebbles, subangular unspecified coarse fragments; strong 10-20mm subangular blocky, moderately moist very firm. Abrupt to-
B21	.06 to .20 m	Brownish black (10YR3/1); medium heavy clay, very few small pebbles, subangular unspecified coarse fragments; strong 2-5mm subangular blocky; moderately moist very firm. Clear to-
B22	.20 to .56 m	Brownish black (10YR3/1); medium heavy clay, very few small pebbles, subangular unspecified coarse fragments, strong 20-50mm lenticular parting to 10-20mm subangular blocky, common distinct clay skins; moderately moist moderately strong; very few medium manganiferous nodules. Clear to-
BC1	.56 to .80 m	Yellowish grey (2.5Y4/1); light medium clay; common small pebbles, angular diorite; strong 10-20mm subangular blocky, few distinct clay skins; moderately moist moderately strong. Clear to-
BC2	.80 to .90 m	Yellowish grey (2.5Y4/1); clay loam; abundant small pebbles, angular diorite; moderate 2-5mm subangular blocky, moderately moist moderately firm. Clear to-

Depth (metres)	1:5 Soil/Water pH	EC mS/cm @105C	Cl % @105C	Particle Size CS %	FS %	S %	C % @105C	Exch. Cations CEC m.eq/100g @105C	Ca	Mg	Na	K	Total Elements P % @80C	K	S	Moistures ADM 1/3b 15b % @105C		Disp.Ratio R1	R2
Bulk .10	6.8	.03	.001																
.06	6.7	.03	.001	10	20	18	53	52	20	20	.44	.38				4.7	35	20	.57
.20	7.0	.05	.003																
.30	7.2	.04	.003	8	17	18	57	54	27	22	.79	.07				5.6	39	22	.63
.56	7.3	.10	.012	10	17	18	53	52	27	24	1.3	.11				5.6	37	21	.61
.90	8.7	.16	.013	55	24	7	13	20	9.3	8.9	.98	.04				2.7	15	07	1.7

Depth (metres)	Org.C (W&B) % @105C	Tot.N % @105C	Extr. Phosphorus Acid ppm @105C	Bicarb. ppm @105C	Rep. K m.eq% @105C	DTPA-extr. Fe ppm @105C	Mn	Cu	Zn
Bulk .10	1.4	.08	39	15	.27	84	32	2.2	0.7
.06	1.9	.07	39	34	.41	107	34	2.4	1.7
.20	1.3	.06	11	4	.13	70	16	2.3	0.7

APPENDIX III (Continued)

SOIL TYPE: 5Dra
SITE NO: S22
A M G. REFERENCE: 531 310 mE 7 811 880 mN ZONE 55

GREAT SOIL GROUP: Non-calcic brown soil
PRINCIPAL PROFILE FORM: Dr2.12
SOIL TAXONOMY UNIT: Udic Paleustalf
FAO UNESCO UNIT: Chromic Luvisol

SUBSTRATE MATERIAL:
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE:
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM:
DOMINANT SPECIES- Eucalyptus drepanophylla, Eucalyptus dichromophloia, Eucalyptus papuana, Heteropogon contortus, Themeda australis

ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY- Hard setting

HORIZON	DEPTH	DESCRIPTION
A1	0 to 20 m	Brownish black (5YR2/1), clay loam; very few small pebbles, subrounded unspecified coarse fragments, weak <2mm granular, dry moderately weak.
B21	20 to .30 m	Reddish brown (2 5YR4/6), dark reddish brown (2.5YR3/2), light medium clay, very few small pebbles, subrounded unspecified coarse fragments, strong 2-5mm subangular blocky, dry very firm Clear to-
B22	.30 to .60 m	Reddish brown (2 5YR4/6), medium clay, very few small pebbles, subrounded unspecified coarse fragments, strong 20-50mm lenticular parting to 5-10mm angular blocky, many prominent clay skins, moderately moist moderately strong; few fine manganiferous soft segregations. Clear to-
BC	60 to 75 m	Bright brown (2.5YR5/6); light clay, very few small pebbles, subangular unspecified rock, strong 5-10mm angular blocky, moderately moist moderately strong. Clear to-
C	.75 to 1.00 m	Abundant medium pebbles, subangular unspecified rock, weak

Depth (metres)	1:5 Soil/Water pH	EC mS/cm @105C	Cl % @105C	Particle Size CS FS % @ 105C	S % @ 105C	C % @ 105C	Exch. Cations CEC m.eq/100g @ 105C	Ca m.eq/100g @ 105C	Mg m.eq/100g @ 105C	Na m.eq/100g @ 105C	K m.eq/100g @ 105C	Total Elements P % @ 80C	K % @ 80C	S % @ 80C	Moistures ADM %	1/3b 15b % @ 105C	Disp Ratio R1	R2
Bulk .10	6.7	.02	.001															
.10	6.8	.02	.001	37	27	11	27	21	8.7	4.0	.15	.44				2.3	18	10	.47	
.20	6.6	.02	.001															
.30	6.7	.02	.001	27	24	8	41	21	9.2	4.2	.21	.10				3.0	23	14	.40	
.60	7.5	.04	.002	18	22	13	48	23	13	6.4	.38	.07				3.5	28	17	.54	
.90	7.8	.02	.001	37	34	8	21	18	11	5.9	.38	.05				3.0	20	09	.83	

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr Acid Phosphorus ppm @ 105C	Bicarb. ppm @ 105C	Rep. K m.eq% @105C	DTPA-extr. Fe ppm @ 105C	Mn ppm @ 105C	Cu ppm @ 105C	Zn ppm @ 105C
Bulk .10	1.0	.08	8	6	28	56	55	1.3	0.6
.10	1.2	.07	6	5	.49	57	47	1.0	0.7
.20	0.8	.06	2	2	.19	52	54	1.1	0.3

SOIL TYPE: 2UgaM
SITE NO: S23A
A M G. REFERENCE: 527 420 mE 7 807 200 mN ZONE 55

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5 28
SOIL TAXONOMY UNIT: Entic Chromustert
FAO UNESCO UNIT: Chromic Vertisol

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: 0.08 m
HORIZONTAL INTERVAL: 6 m
COMPONENT OF MICRORELIEF SAMPLED- Mound

SUBSTRATE MATERIAL.
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE:
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM: Open woodland
DOMINANT SPECIES: Eucalyptus tessellaris

ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY. Periodic cracking, self mulching

HORIZON	DEPTH	DESCRIPTION
A11	0 to .01 m	Medium clay, moderate 2-5mm granular. Abrupt to-
A12	.01 to .10 m	Greyish yellow-brown (10YR4/2), medium clay, moderate 2-5mm subangular blocky, dry very firm. Abrupt to-
B21	.10 to .20 m	Greyish yellow-brown (10YR4/2); medium heavy clay; strong 2-5mm subangular blocky, moist moderately firm; few fine manganiferous nodules Clear to-
B22	.20 to .50 m	Dark greyish yellow (2.5Y4/2), medium heavy clay, strong 10-20mm subangular blocky parting to 2-5mm subangular blocky, moist moderately firm, few medium carbonate nodules, few fine manganiferous nodules. Clear to-
B23k	.50 to 1.10 m	Dark greyish yellow (2.5Y4/2), medium heavy clay, strong 20-50mm lenticular parting to 5-10mm subangular blocky, common distinct clay skins, moderately moist very firm, common medium carbonate nodules, few fine manganiferous nodules. Clear to-
B24	1.10 to 1.25 m	Greyish yellow-brown (10YR4/2); medium heavy clay, strong 20-50mm lenticular parting to 5-10mm subangular blocky, common distinct clay skins, moderately moist very firm; few medium carbonate nodules, few fine manganiferous nodules. Gradual to-
B25	1.25 to 1.50 m	Dull yellowish brown (10YR5/3); medium heavy clay; strong 20-50mm lenticular parting to 5-10mm subangular blocky, common distinct clay skins, moderately moist moderately strong; few medium carbonate nodules, few fine manganiferous nodules. Gradual to-

Depth (metres)	1:5 Soil/Water pH	EC mS/cm @105C	Cl % @105C	Particle Size CS FS % @ 105C	S % @ 105C	C % @ 105C	Exch. Cations CEC m.eq/100g @ 105C	Ca m.eq/100g @ 105C	Mg m.eq/100g @ 105C	Na m.eq/100g @ 105C	K m.eq/100g @ 105C	Total Elements P % @ 80C	K % @ 80C	S % @ 80C	Moistures ADM %	1/3b 15b % @ 105C	Disp.Ratio R1	R2
Bulk .10	7.0	.05	.001															
.10	7.0	.06	.001	3	14	20	65	40	17	13	.80	.59				3.7	34		.44	
.20	7.9	.08	.001															
.30	8.5	.11	.002	3	13	22	64	38	20	16	1.4	.40				5.3	33	19	.56	
.60	8.8	.22	.011	4	13	23	62	39	16	17	3.1	.38				4.3	35	22	.52	
.90	8.9	.42	.032	4	13	18	65	37	14	19	5.1	.37				4.1	38	20	.78	
1.20	8.9	.64	.053	4	15	22	62	35	11	18	6.4	.39				4.4				
1.50	8.4	.68	.064															

Depth (metres)	Org.C (W&B) % @ 105C	Tot.N % @ 105C	Extr Acid Phosphorus ppm @ 105C	Bicarb. ppm @ 105C	Rep. K m.eq% @105C	DTPA-extr. Fe ppm @ 105C	Mn ppm @ 105C	Cu ppm @ 105C	Zn ppm @ 105C
Bulk .10	0.8	.07	3	4	.60	75	31	2.5	0.5
.10	0.9	.07	2	2	.60	51	30	2.3	10
.20	0.7	.04	2	2	.51	22	6	1.5	0.4

APPENDIX III (Continued)

SOIL TYPE: 2UgaD
SITE NO: S23B
A M G. REFERENCE: 527 420 mE 7 807 200 mN ZONE

GREAT SOIL GROUP: Grey clay
PRINCIPAL PROFILE FORM: Ug5.24
SOIL TAXONOMY UNIT: Entic Chromustert
FAO UNESCO UNIT: Pellic Vertisol

TYPE OF MICRORELIEF: Normal gilgai
VERTICAL INTERVAL: 0.08 m
HORIZONTAL INTERVAL: 8 m
COMPONENT OF MICRORELIEF SAMPLED: Depression

SUBSTRATE MATERIAL:
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE:
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM: Open woodland
DOMINANT SPECIES: Eucalyptus tessellaris

ANNUAL RAINFALL.

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY Periodic cracking, self mulching

HORIZON	DEPTH	DESCRIPTION
A11	0 to .01 m	Greyish yellow-brown (10YR4/2), light medium clay; moderate 2-5mm granular
A12	.01 to .10 m	Greyish yellow-brown (10YR4/2), few fine faint brown mottles, light medium clay, strong 2-5mm subangular blocky, dry very firm Sharp to-
B21	.10 to .40 m	Brownish grey (10YR4/1), few fine faint brown mottles, medium heavy clay, strong 2-5mm subangular blocky, moderately moist very firm, very few fine manganiferous nodules Abrupt to-
B22	40 to .80 m	Brownish grey (10YR4/1), very few fine faint brown mottles, medium heavy clay, strong 20-50mm lenticular parting to 5-10mm subangular blocky; common distinct clay skins, moderately moist very firm; very few fine manganiferous nodules. Clear to-
B23k	80 to 1.35 m	Dull yellowish brown (10YR5/3), light medium clay, strong 20-50mm lenticular parting to 5-10mm subangular blocky, common distinct clay skins, moderately moist very firm, few medium carbonate nodules, very few fine manganiferous nodules. Gradual to-
B24	1.35 to 1.70 m	Dull yellowish brown (10YR5/4), light medium clay; strong 20-50mm lenticular parting to 5-10mm subangular blocky, many prominent clay skins, moderately moist very firm, very few medium carbonate nodules, very few fine manganiferous nodules. Gradual to-

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM 1/3b	15b	Disp.Ratio R1	R2
metres		mS/cm	%	%				m.eq/100g					%			%			
		@105C		@ 105C				@ 105C					@ 80C			@ 105C			
Bulk .10	6.1	.04	.001																
.10	6.0	.05	.001	3	23	30	48	34	9	4	9	7	.96	.60		3.4	32	16	53
.20	6.8	.04	.001																
.30	7.2	.06	.003	3	23	23	54	34	14	12	2.0	.26				2.7	33	17	.90
.60	7.9	.15	.016	2	21	26	55	34	15	13	3.3	.25				3.6	35	18	.81
.90	8.5	.30	.032	2	15	21	60	35	16	16	4.8	.31				4.1	37		.92
1.20	8.6	.39	.039	3	17	25	58	35	13	16	5.3	.40				3.7			
1.50	8.5	.43	.048																

Depth	Org.C (W&B)	Tot.N	Extr. Acid	Phosphorus Bicarb	Rep K	DTPA-extr. Fe	Mn	Cu	Zn
metres	%	%	ppm		m.eq%	ppm			
	@ 105C	@ 105C	@ 105C		@105C	@ 105C			
Bulk .10	1.0	.07	5	7	.55	189	41	4.1	1 1
.10	1.3	.09	7	9	.60	207	51	4.7	1.6
.20	0.8	.04	4	3	.38	90	15	3.6	0.4

SOIL TYPE: 1DYC
SITE NO: SGN1
A M G REFERENCE: 529 266 mE 7 804 932 mN ZONE

GREAT SOIL GROUP: Solodized solonetz
PRINCIPAL PROFILE FORM: Dy2.43
SOIL TAXONOMY UNIT: Typic Natrustalf
FAO UNESCO UNIT: Solodic Planosol

SUBSTRATE MATERIAL.
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE: 0.5 %
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM:
DOMINANT SPECIES

ANNUAL RAINFALL.

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1sb	0 to .08 m	Dull yellowish brown (10YR4/3), dry sporadically bleached, common fine distinct brown mottles, clay loam, moderate structure; moderately firm, few ferromanganiferous nodules.
A2cb	.08 to .10 m	Dull yellowish brown (10YR5/3) moist, dull yellowish orange (10YR7/2) dry; conspicuously bleached; common fine distinct brown mottles, clay loam, moderate structure, moderately firm; common ferromanganiferous nodules. Abrupt to-
B21	.10 to .20 m	Greyish yellow-brown (10YR4/2); few fine distinct brown mottles; medium clay, few small pebbles, subrounded unspecified coarse fragments, strong 20-50mm prismatic parting to 2-5mm angular blocky, moderately strong; few ferromanganiferous nodules.
B22	.20 to .45 m	Greyish yellow-brown (10YR4/2); medium clay, few small pebbles, subrounded unspecified coarse fragments, strong 20-50mm angular blocky, moderately strong; few ferromanganiferous nodules.
B23k	.45 to .75 m	Greyish yellow-brown (10YR5/2), medium clay; few small pebbles, subrounded unspecified coarse fragments; strong 20-50mm angular blocky parting to 2-5mm angular blocky, moderately strong; few carbonate soft segregations, very few carbonate concretions.
B24	.75 to 1.50 m	Dull yellowish orange (10YR6/3); medium clay; common small pebbles, subrounded unspecified coarse fragments; strong 20-50mm lenticular parting to 2-5mm lenticular; moderately strong, very few carbonate concretions.
B25	1.50 to 1.70 m	Greyish yellow-brown (10YR6/2); light medium clay; common small pebbles, subrounded unspecified; coarse fragments; strong 2-5mm lenticular; moderately strong; very few carbonate concretions.

Depth	1:5 Soil/Water pH	EC	Cl	Particle Size CS	FS	S	C	Exch. Cations CEC	Ca	Mg	Na	K	Total Elements P	K	S	Moistures ADM 1/3b	15b	Disp.Ratio R1	R2
metres		mS/cm	%	%				m.eq/100g					%			%			
		@105C		@ 105C				@ 105C					@ 80C			@ 105C			
.10	6.7	.02	.001	29	40	14	17	11	3.2	2.9	.69	.14	0.01	0.76	0.01	1.7	15	06	.75
.20	8.7	.20	.006																
.30	9.3	.34	.020	36	27	12	27	18	7.3	7.0	3.6	.13	.005	0.77	0.04	2.5	21	10	.77
.60	9.2	.97	.118	27	25	14	37	26	7.4	9.2	8.4	.23	.005	0.99	0.03	2.9	30	14	1.0
.90	8.6	.87	.118	26	24	14	38	25	6.6	8.6	8.1	.24	.005	1.17	0.02	2.4	32	15	1.0
1.20	8.5	.73	.098	30	25	12	35	22	6.0	7.7	7.5	.23	.005	1.23	0.01	2.7			
1.50	8.3	.77	.108																

Depth	Org.C (W&B)	Tot.N	Extr. Acid	Phosphorus Bicarb.	Rep. K	DTPA-extr. Fe	Mn	Cu	Zn
metres	%	%	ppm		m.eq%	ppm			
	@ 105C	@ 105C	@ 105C		@105C	@ 105C			
.10	0.7	.04	3	2	.15	42	27	0.9	0.2
.20	0.5	.04	2	2	.15	16	15	1.0	0.2

APPENDIX III (Continued)

SOIL TYPE: 1DYC
SITE NO: SGN2
A M G. REFERENCE: 529 310 mE 7 805 020 mN ZONE

GREAT SOIL GROUP: Solodic soil
PRINCIPAL PROFILE FORM: Dy2.43
SOIL TAXONOMY UNIT: Typic Natrustalf
FAO UNESCO UNIT: Solodic Planosol

SURFACE COARSE FRAGMENTS: Few coarse pebbles, subangular unspecified coarse fragments

SUBSTRATE MATERIAL:
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE: 0.5 %
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM:
DOMINANT SPECIES

ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY: Hardsetting

HORIZON	DEPTH	DESCRIPTION
A1sb	0 to .05 m	Greyish yellow-brown (10YR4/2); dry sporadically bleached, common fine distinct brown mottles, clay loam; weak <2mm granular, moderately firm, few ferromanganiferous nodules.
A2cb	05 to .06 m	Greyish yellow-brown (10YR4/2) moist, dull yellowish orange (10YR7/2) dry, conspicuously bleached, common fine distinct brown mottles; clay loam, moderate structure; moderately firm, few ferromanganiferous nodules. Abrupt to-
B21	06 to .15 m	Yellowish grey (2.5Y4/1); common fine distinct brown mottles; medium clay, few small pebbles, subrounded unspecified coarse fragments, strong 5-10mm subangular blocky, moderately strong, few ferromanganiferous nodules. Abrupt to-
B22	.15 to 25 m	Yellowish grey (2.5Y4/1); medium clay, few small pebbles, subrounded unspecified coarse fragments, strong 2-5mm subangular blocky, moderately strong, few ferromanganiferous nodules. Abrupt to-
B23k	.25 to 65 m	Yellowish grey (2.5Y4/1), medium clay, few small pebbles, subrounded unspecified coarse fragments, strong 5-10mm subangular blocky parting to 2-5mm subangular blocky, moderately strong, few carbonate nodules, few ferromanganiferous nodules. Clear to-
B24nk	.65 to 1.50 m	Greyish yellow (2.5Y6/2); medium clay; few small pebbles, subrounded unspecified coarse fragments, strong 10-20mm lenticular, moderately strong, few carbonate nodules, common manganiferous soft segregations.

Depth metres	1:5 Soil/Water pH	EC mS/cm @105C	Cl % @105C	Particle Size CS FS %	S %	C % @105C	CEC	Exch. Cations Ca	Mg	Na	K m.eq/100g @105C	Total Elements P % @80C	K %	S %	Moistures ADM	1/3b % @105C	15b % @105C	Disp.Ratio R1	R2
.06	6.7	03	.002	31	35	24	16	11	2.2	2.7	.54	.28	0.01	0.60	0.01	1.5	19	06	.78	
.20	8 3	.17	.020																	
.30	8.9	.51	.050	13	18	21	51	35	12	14	7.2	.20	.005	0.47	0.05	4.0	36	19	.98	
.60	9.0	1.0	.118	15	17	19	53	33	11	14	9.8	.23	.005	0.63	0.04	4.0	35	20	.95	
.90	8.5	.95	.128	14	22	18	49	31	9.1	12	9.7	.31	.005	0.98	0.02	3.9	36	18	.98	
1.20	8.5	.76	.098	18	23	14	46	29	8.2	11	9.0	.30	0.01	1.01	0.01	3.5				
1.50	8.5	.67	.086																	

Depth metres	Org.C (W&B) % @105C	Tot.N % @105C	Extr. Acid ppm @105C	Phosphorus Bicarb. ppm @105C	Rep. K m.eq% @105C	DTPA-extr. Fe ppm @105C	Mn	Cu	Zn
.06	1.0	.06	4	2	.28	58	29	0.7	0.2
.20	0.6	.04	2	2	.17	17	14	1.2	0.3

SOIL TYPE: 1UGF
SITE NO: SGN3
A M G REFERENCE: 529 290 mE 7 805 155 mN ZONE

GREAT SOIL GROUP: No suitable group
PRINCIPAL PROFILE FORM: Ug3.2
SOIL TAXONOMY UNIT: Entic Pellustert
FAO UNESCO UNIT: Chromic Vertisol

SUBSTRATE MATERIAL:
CONFIDENCE SUBSTRATE IS PARENT MATERIAL:

SLOPE: 0.5 %
LANDFORM ELEMENT TYPE:
LANDFORM PATTERN TYPE:

VEGETATION
STRUCTURAL FORM:
DOMINANT SPECIES

ANNUAL RAINFALL:

PROFILE MORPHOLOGY:
CONDITION OF SURFACE SOIL WHEN DRY: Periodic cracking, hardsetting

HORIZON	DEPTH	DESCRIPTION
A1sb	0 to .12 m	Yellowish grey (2.5Y5/1); dry sporadically bleached; common coarse distinct brown mottles, light clay; few small pebbles, subrounded unspecified coarse fragments, weak 2-5mm granular; moderately firm, few fine manganiferous nodules.
A2cb	.12 to .14 m	Yellowish grey (2.5Y5/1), dry conspicuously bleached; common coarse distinct brown mottles; light clay; few small pebbles, subrounded unspecified coarse fragments, weak 2-5mm granular, moderately firm, few fine manganiferous nodules. Abrupt to-
B21	.14 to .28 m	Dark greyish yellow (2.5Y5/2); common medium distinct yellow mottles; medium clay, few small pebbles, subrounded unspecified coarse fragments; strong 10-20mm subangular blocky parting to 2-5mm subangular blocky; moderately strong; few fine manganiferous nodules. Abrupt to-
B22	.28 to .65 m	Dark greyish yellow (2.5Y5/2); medium clay; few small pebbles, subrounded unspecified coarse fragments; strong 10-20mm subangular blocky parting to 2-5mm subangular blocky, moderately strong, few fine manganiferous nodules. Clear to-
B23k	.65 to .90 m	Dark greyish yellow (2.5Y5/2); medium clay; few small pebbles, subrounded unspecified coarse fragments; strong 10-20mm lenticular parting to 2-5mm lenticular; moderately strong; few fine carbonate concretions. Clear to-
B24nk	.90 to 1.50 m	Dull yellow (2.5Y6/3), dull yellow (2.5Y6/4); medium clay, few small pebbles, subrounded unspecified coarse fragments; strong 10-20mm lenticular parting to 2-5mm lenticular; moderately strong; common manganiferous soft segregations, few fine carbonate concretions.

Depth metres	1:5 Soil/Water pH	EC mS/cm @105C	Cl % @105C	Particle Size CS FS %	S %	C % @105C	CEC	Exch. Cations Ca	Mg	Na	K m.eq/100g @105C	Total Elements P % @80C	K %	S %	Moistures ADM	1/3b % @105C	15b % @105C	Disp.Ratio R1	R2
.10	6.6	.03	.002	21	32	12	33	22	4.5	6.4	.64	.60	0.02	0.45	0.02	2.9	21	11	.36	
.20	6.7	.04	.004																	
.30	7.4	.10	.012	18	20	11	49	30	8.3	12	3.0	.19	0.01	0.35	0.01	3.3	34	17	.83	
.60	8.6	.66	.088	17	21	15	46	30	8.7	15	6.1	.21		0.38	0.03	3.6	31	17	1.1	
.90	9.0	1.0	.124	15	23	17	46	30	8.5	13	7.6	.25		0.65	0.04	3.2	32	17	1.0	
1.20	9.1	1.0	.118	17	30	13	41	27	7.4	11	7.1	.26	.005	0.88	0.03	2.9				
1.50	9.1	.96	.108																	

Depth metres	Org.C (W&B) % @105C	Tot.N % @105C	Extr. Acid ppm @105C	Phosphorus Bicarb. ppm @105C	Rep. K m.eq% @105C	DTPA-extr. Fe ppm @105C	Mn	Cu	Zn
.10	0.8	.06	3	2	.56	52	54	1.2	0.3
.20	0.6	.05	2	2	.29	36	45	1.0	0.2

APPENDIX IV IRRIGATION LAND SUITABILITY CLASSES, BURDEKIN RIVER IRRIGATION AREA

Class 1. Land suitable for crop production under irrigation with no or minor limitations.

(a) It is highly productive requiring only fertiliser input.

(b) Land with attributes which allow greatest water application efficiency without the use of specialised irrigation management techniques.

(c) Land which requires no or minor land modification in preparation for irrigation.

(d) Potential erosion and salinity hazards are negligible under irrigation.

Class 2. Land suitable for crop production under irrigation but with slight limitations to use in one or more of the following categories.

(a) Land with some limitations to crop growth requiring amendment(s) to attain satisfactory productivity.

(b) Land with attributes which require the use of some specialised irrigation management techniques to achieve satisfactory water application efficiency, crop establishment and growth.

(c) Land which requires some land modifications, for example levelling, stone picking in preparation for irrigation.

(d) Simple conservation measures only are required to reduce soil loss to an acceptable level and potential secondary salinisation is not expected under irrigation.

Class 3. Land suitable for crop production under irrigation but with moderate limitations to use in one or more of the following categories.

(a) Land with moderate limitations to crop growth requiring rehabilitation or treatment to attain satisfactory productivity.

(b) Land with attributes such that there will be an even greater requirement to use specialised irrigation management techniques to achieve satisfactory water application efficiency, crop establishment and growth.

(c) Land which requires a moderate degree of land modification, for example levelling, stone picking in preparation for irrigation.

APPENDIX IV (Continued)

(d) Land which requires graded banks as well as simple conservation measures to reduce soil loss to an acceptable level. Potential secondary salinisation is not expected to occur under irrigation.

Class 4. Land currently unsuitable for crop production under irrigation with such severe limitations that special agronomic, edaphic, economic and/or engineering studies are required to show it to be capable of sustained economic crop production.

(a) Land on which crop growth under irrigation would be very poor without intensive reclamation measures.

(b) Land with attributes, such that satisfactory water application efficiency, crop establishment and growth cannot be achieved with current irrigation management techniques.

(c) Land which requires such a degree of land modification, for example, levelling, stone picking, drainage, in preparation for irrigation that it will not be economically feasible with current technology.

(d) Land which cannot be used for continuous crop production under irrigation due to excessive soil loss even with conservation measures applied. The potential for secondary salinisation is high.

Class 5. Land which is not suitable for the long term production of crops under irrigation due to one or more of the following limitations.

(a) Land whose limitations to crop growth cannot be corrected with existing technologies.

(b) Land with such attributes that water application efficiency, crop establishment and growth cannot be achieved.

(c) Land which cannot be prepared for irrigation use.

(d) Land on which the level of soil conservation works required to reduce soil loss to an acceptable level would unduly hinder farming operations or land that is subject to regular damaging erosive flooding.

APPENDIX V LAND SUITABILITY CLASSIFICATION FOR CROPS OTHER THAN RICE, BURDEKIN RIVER IRRIGATION AREA.

Limiting factor	Nature and degree of limitation	Subclass
Soil depth	Refers to rock, pan or readily observable restriction which will affect root development and plant available water. Does not refer to effective rooting depth as suggested by salinity, sodicity or bulk density.	
	0.6 - 1.0 m	d2
	0.45 - 0.6 m	d3
	0.25 - 0.45 m	d4
	< 0.25 m	d5
Depth to hard/slowly permeable subsoils	Hard subsoils reduce water entry, available water capacity and restrict root development.	
	Depth to B horizon of duplex soils with dry moderately strong, very strong or rigid consistence.	
	0.2 - 0.4 m	pb2
	0.1 - 0.2 m	pb3
	< 0.1 m	pb4
Nature of surface soils	Crop emergence is limited if soils have large aggregates at the surface or set too hard.	
	(a) Cracking clay soils	
	* Percentage of peds or fragments > 5 mm diameter on surface is:	
	25 - 45	ps2
	> 45	ps3
	(b) Other soils	
	Surface may set hard if overworked and there maybe difficulties in achieving satisfactory germination.	ps2
	Surface soils set hard. Some difficulty in achieving satisfactory germination.	ps3
	Surface soils set very hard; may seal on wetting, forming dense crusts on drying; very difficult to establish and maintain tilth and achieve satisfactory germination.	ps4

* Based on data reported in Gardner and Coughlan (1982)

APPENDIX V (Continued)

Limiting factor	Nature of degree of limitation	Subclass
Distribution of soils	Where two or more soils occur in a 300 m traverse, (300 m is regarded as minimum run length for furrow irrigation) and differ in depth or texture of the surface, and/or internal drainage characteristics such that even under good management, crop yields may differ markedly. Criteria are:	
	B horizon permeability is similar but A horizon depths differ by a factor of 1.5 to 2+ where A horizon depth of one soil is greater than 0.2 m and/or A horizon field textures differ by > 2 field texture groups.++	pd3
	B horizon permeabilities differ markedly and/or A horizon depths differ by a factor of > 2 where A horizon depth of one soil is greater than 0.2 m and/or A horizon field textures differ by > 2 texture groups.	pd4
Texture of surface soils	Method of irrigation is dependent on surface texture. Furrow irrigation is more difficult with deeper sands; spray irrigation becomes essential.	
	Surface textures of sands to sandy loams to depths of:	
	0.45 - 0.6 m	pt2
	0.6 - 0.9 m	pt3
	> 0.9 m	pt4
Salinity	Salts in the upper part of the soil affect crop growth.	
	Electrical conductivity of 1:5 suspension at 25°C is > 1.0 dS m^{-1} at :	
	0.3 - 0.9 m	sa3
	< 0.3 m	sa4

+ Depth differences determined by multiplication
++ Northcote (1979)

APPENDIX V (Continued)

Limiting factor	Nature of degree of limitation	Subclass
Sodicity	High sodicity causes soil dispersion, loss of pore space, restricted rooting depth and plant available water capacity.	
	EITHER	
	ESP at 0.2 - 0.3 m	
	is:	
	6 to 14	so3
	> 14	so4
	OR (where no ESP data)*	
	Field pH at 0.2 - 0.3 m is:	
	(a) For cracking clays	
	8.0 to 9.5	so3
	> 9.5	so4
	(b) For solodic soils and solodized-solonetz	
	6.5 to 8.0	so3
	> 8.0	so4
Topography	Slope influences water management, ease of development, layout, and erosion control. (Angled layout not considered)	
	Even slopes of	
	0.25 to 1.0%	t2
	1.0 to 2.0%	t3
	< 0.03 or 2.0 to 6.0%	t4
	> 6.0%	t5
Fertility	Fertility can be very low in some soils. This alters the economic basis of development.	
	From soil analyses described in Bruce and Rayment (1982), the following combination can be determined for plant nutrients:	
	1 to 2 nutrients are very low	n2
	> 2 nutrients are very low	n3

* Relationship from Baker, Rayment and Reid (1983)

APPENDIX V (Continued)

Limiting factor	Nature of degree of limitation	Subclass
Rockiness and stoniness	The presence of rocks on the surface and in surface soil affects cultivation and other cultural operations.	
	Some picking of cobbles for certain management requirements (e.g. harvesting soybeans).	r2
	Tillage restricted, picking of cobbles and stones required.	r3
	Tillage difficult, picking of cobbles and stones required.	r4
	Tillage impractical, stones and boulders too numerous to warrant removal or rockland.	r5
Microrelief	Uneven surfaces create the need for careful levelling. Costs increase with depth of levelling required. Soil chemical and physical problems with exposed subsoils are often associated.	
	Vertical interval of gilgai, or of other regular microrelief	
	0.1 - 0.25 m	g2
	0.25 - 0.6 m	g3
	> 0.6 m	g4
Wetness	Areas which remain wet after rainfall, cannot be used until drainage has taken place. (Includes both internal (soil) and external (site) aspects of drainage).	
	Areas which are wet for some time; require levelling including some cut and fill.	w3
	Areas which are wet for many months after wet season; considerable filling, or special drainage, or other considerable reclamation necessary.	w4
	Areas which are wet for most of the year and are uneconomical to reclaim.	w5

APPENDIX V (Continued)

Limiting factor	Nature and degree of limitation	Subclass
Water erosion	Soils susceptible to erosion need to be protected to maintain productivity.	
	Susceptible to erosion, control measures required are:	
	Simple practices, for example, maintenance of cover.	e2
	Intensive practices, for example, graded banks.	e3
	Pasture phase or permanent pasture.	e4
	Gully erosion so severe, that measures to rehabiliate these areas would be uneconomical.	e5
Flooding	Areas susceptible to flooding at critical stages of crop growth pose limitations to development because of yield reduction or total loss of crops.	
	Areas subjected to local flooding at different frequencies. Crop damage or losses may occur.	
	Frequency of flooding < 1 in 10 years. Minor wet season crop losses or damage can be expected.	f2
	Frequency of flooding 1 in 5 to 10 years.	f3
	Frequency of flooding > 1 in 5 years. Cropping during wet season is not recommended due to frequency of flooding. Low lying areas adjacent to creeks and their outlets.	f4
	Areas subjected to erosive flooding.	f5

APPENDIX V (Continued)

Limiting factor	Nature and degree of limitation	Subclass
Intake or recharge attributes	Refers to intake areas where excessive amounts of irrigation and rain water losses to the groundwater can cause off-site seepage and salinisation.	
	Intake to groundwater is such that it can be minimized with:	
	Simple management and design.	i2
	Special management and design, for example, use of sprinkler irrigation.	i3
	Restricted cropping management and design, for example, trickle irrigation of deep rooted tree crops.	i4
	Where accessions to groundwater are excessive and cannot be prevented.	i5
Outflow or discharge attributes, susceptibility to rise in groundwater.	Areas which have a history of seepage or secondary salinisation or are suspected of same, will not be productive or will be very risky to develop. Lower slopes of the gently undulating rises are susceptible. Edges of the Burdekin River levee may also be susceptible.	
	Known/suspected secondary salinisation	04

APPENDIX VI LAND SUITABILITY CLASSIFICATION FOR RICE, BURDEKIN RIVER IRRIGATION AREA

Limiting factor	Nature and degree of limitation	Subclass
Topography	Simple slopes of 0.03 to 0.25% are regarded as the most suitable	
	0.03 to 0.25% complex slope	t2
	< 0.03 or 0.25 to 0.5% simple or complex slope	t3
	0.5 to 0.75% simple slope	t4
	Any slope > 0.75% and/or complex slopes of 0.5 -0.75%	t5
Microrelief	Vertical interval of gilgai (m)	
	0.1 to 0.25 m	g2
	0.25 to 0.6 m	g3
	> 0.6 m	g4
Flooding	Areas subject to local flooding more than 1 in 10 years but less often than 1 in 5 years.	f2
	Areas subject to local flooding more often than 1 in 5 years.	f3
	Areas subject to erosive flooding.	f5
Profile permeability	Duplex soils with A horzions of < 0.2 m, moderately strong, very strong or rigid upperB horizons and textures in the clay range from the base of the A horizons to > 1.5 m, and strongly alkaline (or with ESP > 15) by 0.6 m are considered the least permeable.	
	Cracking clay soils with alkaline soil reaction trend and/or ESP at some point in the profile > 15 and texture in the clay range extending to > 1.5 m.	p2
	Duplex soils with A horizons > 0.2 m deep, moderately strong, very strong or rigid upper B horizons and textures in the clay range from the base of the A horizon to > 1.5 m. Alkaline soil reaction trend and/or ESP at some point in the profile > 15.	p3
	As for p3 but upper B horizon not moderately strong.	p4
	All uniform, duplex and gradational soils with acid and neutral soil reaction trends with ESP < 15 throughout profile and/or with some material with texture coarser than sandy clay between 0.4 and 1.5 m.	p5